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U. S. DEPARTMENT OF AGRICULTURE.

Report No. 81.

REPORT

OF THE

SECRETARY OF AGRICULTURE.

1905.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
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REPORT

OF THE

SECRETARY OF AGRICULTURE.

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To THE PRESIDENT:

I have the honor to submit herewith my Ninth Annual Report as Secretary of Agriculture.

INTRODUCTORY.

The well-being of the American farmer is a matter of profound interest to the entire country. It is, therefore, in the highest degree gratifying to present for your consideration the following evidences of the unprecedented prosperity which has in this and recent years rewarded the diligence of the farmer and the efforts of this Department on his behalf.

FARMER'S WEALTH AND WELL-BEING.

UNSURPASSED PROSPERITY.

Another year of unsurpassed prosperity to the farmers of this country has been added to the most remarkable series of similar years that has come to the farmers of any country in the annals of the world's agriculture. Production has been unequaled; its value has reached the highest figure yet attained; the value of the farmers' National surplus still maintains the magnitude that has built up the balance of trade by successive additions for many years sufficient to change the Nation from a borrower into a lender; there is a continuation of the unprecedented savings that have embarrassed local banks with their riches and have troubled farmers to find investments; and, as if all of these manifestations of a high degree of well-being were not enough, the farms themselves have increased in value to a fabulous extent.

Farm crops have never before been harvested at such a high general level of production and value. The partial failure of two or three second-class crops makes no apparent impression upon the great aggregate of all crops.

After much laborious collection of information an estimate of the value of the crops of 1905 and of all other farm products has been made, as was done last year. The census's detailed statement of the value of all farm products was taken as the basis, and the various items have been brought down from year to year in their quantities

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and values. For such crops as will later receive a final estimate by the Bureau of Statistics of this Department, the figures herein used are subject to small correction. All values adopted for the various products are farm values, and are in no wise to be mistaken for exchange, middleman's, or consumer's values.

HIGH CROP VALUES.

Corn has reached its highest production with 2,708,000,000 bushels, a gain of 42,000,000 over the next lower year, 1899. In value, also, the corn crop of this year is higher than that of the next lower year, 1904, by $128,000,000, and the total value may be $1,216,000,000. No other crop is worth more than half as much.

Hay.—Second in order of value among all kinds of crops is the hay crop, which takes the second place back from the cotton crop, which held it for the two preceding years. Many hay crops have exceeded in tons the product of this year, but because of high prices the crop reaches a value of $605,000,000, which is higher by $34,000,000 than the value of the crop of 1893.

Cotton, including seed, stands third in value among the leading crops of the year, although some uncertainty still remains concerning its quantity and value. It can only be said that its value, including seed, is expected to rise well toward $575,000,000, and will be nearer to that figure, or above it, in proportion as the expectations of cotton planters are realized with regard to higher prices.

Wheat.—Fears last year that the United States had fallen to the level of its consumption in the production of wheat were ill-founded. The short crop of that year is followed this year by the second wheat crop in size that this country has ever produced, 684,000,000 bushels, and the value of this crop, $525,000,000, overtops the highest value before reached, in 1891, by $11,000,000.

Oats.—Fifth in order of value among the crops of the year is the oat crop, with 939,000,000 bushels, or 50,000,000 bushels under the highest production, in 1902. In value as well as yield the oat crop of this year has been exceeded in only two previous years, amounting to $282,000,000, only $22,000,000 under that of 1902.

Potatoes.—Next after oats comes the potato crop, which has been a partial failure and falls below the highest production of preceding years, that of 1904, by 72,000,000 bushels; but in value the crop has done better, since it occupies the fourth place from the highest, and is valued at $138,000,000, or only $13,000,000 below the highest preceding value, that for 1903.

Barley.—The high price of barley during the last three years has much increased the size and value of this crop, so that it now occupies seventh place among the leading agricultural crops. In quantity the crop of this year, 133,000,000 bushels, is third among annual barley crops, though only 7,000,000 bushels under the highest crop, that of 1904, and has a value of $58,000,000, or only $4,000,000 under the most valuable crop of this cereal, that of 1902.

Tobacco, like potatoes, is an undersized crop this year, as it was last year, and, considering the difficulties in the way of placing a value upon it at this time, an estimate of $52,000,000 may be too low. At any rate, because of high prices, the entire crop almost exceeds the highest value yet reached, that of 1899.

Sugar cane and sugar beets.—Although unrelated in culture, the common purpose of growing sugar beets and sugar cane permits their combination in a statement that their united value this year is estimated to be in the neighborhood of $50,000,000. This is a farm value for the raw material from which sugar, sirup, molasses, and feeding stuffs are derived in processes of manufacture.

Rice.—The rice crop is not as valuable as some other crops which are not mentioned here, yet its remarkable position entitles it to notice. Its production increased from 250,000,000 pounds of rough rice in 1899 to 517,000,000 pounds in 1903 and to 928,000,000 pounds in 1904; but the extraordinary production of 1904 fell to 637,000,000 pounds this year, and, although second in quantity, this year's crop is probably worth more than the crop of 1904, which was valued at $13,892,000.

Exceptional general level.—While it may be observed that only one crop—corn—reached its highest production this year, four crops reached their highest value—namely, corn, hay, wheat, and rice. The general level of production was high and that of prices still higher, so that no crops for which separate estimates can be made fall below third place in total value compared with the crops of preceding years, except potatoes, barley, tobacco, rye, and buckwheat. The cereals, including rice, more than maintained their previous strong position in production, and their aggregate yield is 4,521,000,000 bushels, with a farm value of $2,123,000,000, or $145,000,000 over last year.

DAIRY AND POULTRY PRODUCTS.

Butter and milk.—Both butter and milk have higher prices in 1905 than in 1904, and these, combined with increased production, permit an estimate of the value of dairy products at $665,000,000, or $54,000,000 above the estimate for last year. No crop but corn produces the income that the dairy cow does.

The farmer's hen is becoming a worthy companion to his cow. The annual production of eggs is now a score of billions, and, after supplying the needs of factories, tanneries, bakeries, and other trades, they are becoming a substitute for high-priced meats, besides entering more generally into the everyday food of the people. Poultry products have now climbed to a place of more than half a billion dollars in value; and so the farmer's hen competes with wheat for precedence.

TOTAL WEALTH PRODUCTION ON FARMS.

Dreams of wealth production could hardly equal the preceding figures into which various items of the farmer's industry have been translated; and yet the story is not done. When other items, which can not find place here, are included, it appears that the wealth production on farms in 1905 reached the highest amount ever attained by the farmer of this or any other country, a stupendous aggregate of results of brain and muscle and machine, amounting in value to $6,415,000,000.

The deduction from wealth produced, made in the report of last year on account of products fed to live stock, is not continued this year because the duplication of produced wealth in the consumption of products by farm animals is much less than has been assumed

and is undoubtedly more than offset by the amount of wealth produced on farms which can not be estimated or even ascertained practically by census enumerators.

It might reasonably have been supposed in 1904 that the wealth produced by farmers had reached a value which would not be equaled perhaps for some years to follow, and yet that value is exceeded by the value for this year by $256,000,000, just as the value for that year exceeded that for 1903 by $242,000,000.

The grand aggregate of wealth produced on farms in 1905 exceeds that of 1904 by 4 per cent; it is greater than that of 1903 by 8 per cent; and transcends the census figures for 1899 by 36 per cent, and this after a lapse of only six years.

If there is no relapse from this high position that the farmer now holds as a wealth producer, three years hence he may look back over the preceding decade, and, if he will add the annual figures of his wealth production, he will find that the farming element, or about 35 per cent of the population, has produced an amount of wealth within these ten years equal to one-half of the entire National wealth produced by the toil and composed of the surpluses and savings of three centuries.

DOMESTIC ANIMALS.

Horses.—In the last annual estimate made by this Department of the number and value of domestic animals on farms, nearly a year ago, it appears that the farmers' horses had never before been so numerous nor in the aggregate so valuable. First threatened by the bicycle, and later by the suburban trolley car and the automobile, neither one of these, nor all combined, have scared the farmers' horses into diminished numbers or lower prices. On the contrary, horses on farms last winter were worth $1,200,000,000, or nearly as much as the corn crop of this year, and their number was over 17,000,000. Mules also are steadily increasing, and are worth $252,000,000.

Cattle.—Milch cows also are advancing in numbers and have reached a total of 17,570,000, worth $482,000,000. Other cattle, however, have not participated in this advance, and in recent years have declined in number and total value so that last winter they numbered 43,669,000, worth $662,000,000.

Sheep and swine.—Sheep, too, are declining in number and in total value, but swine are holding their previous position of many years, the number being 47,321,000, valued at $283,255,000.

Aggregate increase.—In the aggregate, the value of farm animals of all sorts has increased a few million dollars within a year and has increased $249,000,000 since the census of 1900, or 9 per cent.

FEATURES OF FOREIGN TRADE.

Unparalleled agricultural surplus.—Out of the enormous productions of the farms of this country the wants of 83,000,000 people have been supplied, and there remains a surplus large enough to become a generous contribution to the other nations of the earth and unparalleled among them as a National agricultural surplus.

During the last fiscal year (ending June 30, 1905) the exported domestic farm products were valued at $827,000,000. This was $51,000,000 below the annual average of the five preceding years,

although it was $132,000,000 above the average of the five years 1895–1899, and $157,000,000 above the average of 1890–1894.

There was a loss of $32,000,000 as compared with the exports of farm products for the fiscal year 1904. In accounting for this it is proper to notice that the decrease in the exports of grain and grain products, due to the short wheat crop, equaled $41,000,000. To this decrease is to be added a reduction of $5,000,000 in exports of packing-house products, and another of $5,000,000 in fruits, and various minor items.

On the other hand, however, there were increases of $9,350,000 in exports of cotton; $4,700,000 in oil cake and oil-cake meal; $4,000,000 in vegetable oils; $2,000,000 in rice, and various minor increases.

The relative position of farm products in domestic exports is a declining one on account of the gain in exports of manufactures, so that, while the exports of the former averaged 62.6 per cent of all domestic exports for the five years 1900–1904, the percentage for 1905 was only 55.4 per cent.

During the last sixteen years the domestic exports of farm products have amounted to $12,000,000,000, or $1,000,000,000 more than enough to buy all the railroads of the country at their commercial valuation, and this with a mere surplus for which there was no demand at home.

Imports mostly noncompetitive.—In the matter of imports of farm products the total of the last fiscal year was $554,000,000, or $125,000,000 more than the annual average of the preceding five years. Over 1904 the gain was $92,000,000, which is accounted for by large increases in the imports of silk, wool, hides and skins, coffee, sugar, and molasses, against which there were relatively small decreases in imports of feathers, rice, tea, and vegetables. The imports of farm products in 1905 were 49.6 per cent of all imports, as compared with 46.7 per cent during the preceding five years.

Apparent balance of trade.—While the farmer has been a producer and a trader, he has also been an international paymaster. In his foreign trade of 1905 he had a net balance in his favor amounting to $285,000,000; in the preceding five years this favorable balance averaged $461,000,000; during the five years 1895–1899 it averaged $338,000,000, and in the five years preceding that the average was $271,000,000.

During the sixteen years past the farmer has secured a balance of $5,635,000,000 to himself in his international bookkeeping, and out of this he has offset an adverse balance of $543,000,000 in the foreign trade in products other than agricultural, and turned over to the Nation from his account with other nations $5,092,000,000.

Foreign trade in forest products.—Notwithstanding the constant weakening of the National forest resources, the exports of forest products had been increasing for many years, but during the fiscal year 1905 their value was $63,000,000, which was a decline of $6,300,000 from the preceding year.

Imported forest products are either noncompetitive with those of the Nation or introduced from Canada because of insufficient domestic production. The imports of 1905 were valued at $92,000,000, an increase of $12,000,000 over the preceding year, mostly on account of increased imports of india rubber, but partly on account of increased imports of lumber and wood pulp from Canada.

FARMERS' SUPPORT OF MANUFACTURING.

Not content with his other achievements, the farmer lends his strong shoulder to the support of the manufactures of the country by furnishing raw materials. Computations based upon census information disclose the fact that farm products, to some extent obtained from other countries, constitute 56.4 per cent of the total products, and 86.8 per cent of the total materials, of the industries utilizing agricultural products as materials, and these industries produce 36.3 per cent of all manufactured products and use 42 per cent of all materials employed in manufacturing.

At the same time these industries using agricultural materials employed 37.8 per cent of all persons engaged in manufacturing, and the capital of these industries is 42.1 per cent of the capital of all manufacturing establishments.

Restated in absolute terms, during the last census year the farm products employed in manufactures were valued at $2,679,000,000; the value of all materials, including the preceding amount, was $3,087,000,000; and the products of the industries using these materials were valued at $4,720,000,000. These industries employed 2,154,000 persons and had a capital of $4,132,000,000.

Such are the enormous interests, not engaged in agriculture, but in industries that could not maintain themselves without the farmer and his extraordinary productive ability.

FARMERS BECOMING BANKERS.

Naturally such a large class of the population as the farmers, producing wealth and surpluses to the extent that they are, have savings which they invest in various ways, since in this country the stocking and its hiding place are not the savings bank. One of the most notable outgrowths of savings by farmers is the very great multiplication of small national banks in recent years. Under the amendment to the national banking act, permitting the organization of banks with a capital of less than $50,000, as many as 1,754 of these banks were organized from March 14, 1900, to October 31, 1905, excluding those organized in the noncontiguous possessions. These banks are distributed mostly throughout the South and the North Central States in rural regions, where they depend for their business primarily and directly upon the farmers' prosperity and, secondarily, upon the village merchants and persons of other employment, who themselves are dependent upon the prosperity of the farmers.

In the Southern States 633 of these banks were organized, representing 36.1 per cent of the total number; in the North Central States the number was 792, or 45.2 per cent of the total. To one who is familiar with State and regional conditions it is significant to notice that in the North Central States west of the Mississippi River 513 of these banks were organized, representing 29.3 per cent of the total number, and that in the Southwestern region, embracing Texas, Indian Territory, and Oklahoma, 397 new small banks stand for 26.2 per cent of the total.

If the capital of these banks had been sent from Boston and New York it would have been such a proceeding as was common fifteen years ago; but, instead of coming from such an origin, the capital

of these banks has come from the farmers. The State bank commissioner of Kansas, in his report for 1904, states that "it has been an era of small banks in isolated communities, and so many have been started that to-day every hamlet in the State where any considerable business is done has a bank. This increase in the number of small banks arises, first, from the fact that farmers and business men in these communities had idle money that they desired to invest and banking appealed to them," etc. The same cause for the establishment of these banks is reported from the South and North Central and Western groups of States.

DEPOSITORS IN BANKS.

In the North Central States farmers have been depositing money in the banks until the rate of interest on deposits has fallen so low that they have diverted a large portion of their savings to permanent investments. In spite of the fact that the banks do not receive and keep all or most of the farmers' savings, the increase of bank deposits in agricultural States and larger regions is most extraordinary. The following are some examples of the increase of the deposits in all banks in the agricultural States during the year ending June 30, 1905: In Iowa and South Dakota the increase was 14.9 per cent; in Nebraska, 13.5; in Kansas, 9.7; in North Dakota, 25. During the same time bank deposits in the great capital State of Massachusetts increased 9.1 per cent.

Still more remarkable is the bank statement for the South Central States. During the past year the deposits increased 18.1 per cent in Texas, 21.4 in Oklahoma, 24.1 per cent in Arkansas, and 45.7 per cent in the Indian Territory, while throughout the whole area of that geographic division the increase was 22.8 per cent. The general average increase for the United States was 13.5 per cent.

If a comparison is made with 1896, within the latest prolonged financial depression, the comparisons are still more striking. During the ten years from that year to June 30, 1905, the bank deposits of the United States, all banks included, increased 129.2 per cent. In comparison with this is the increase of the South Atlantic States, 167.4 per cent; of the Western or Rocky Mountain and Pacific States, 169.8 per cent; of the North Central States, 185.5 per cent; and still more striking is the percentage of the South Central States, 255.7 per cent; while during the same time the deposits in the North Atlantic States increased only 102.3 per cent.

For individual States there are such increases during the ten years as 190.9 per cent for Iowa, 239.3 per cent for Kansas, 294 per cent for North Dakota, and 355.7 per cent for South Dakota. The progress of the South Central States was still more rapid, as evidenced in particular by Mississippi, with an increase of 347.1 per cent in bank deposits; by Texas, 248 per cent; by Oklahoma, 172.6 per cent; and by Arkansas, with 503.8 per cent.

For the first time in the financial history of the South, deposits in the banks of that region now exceed $1,000,000,000.

The foregoing remarkable increases in bank deposits in agricultural States, as well as the increase in the number of small country banks, are directly and indirectly because of the profits that have come to

the farmers from the operation of their farms. The man with the hoe has become the man with the harvester and the depositor and shareholder of the bank.

DECADENCE OF THE CROP LIEN.

Nothing has been of greater financial moment to the cotton planters than the profitable price of cotton during the past three years. It has been the means of lifting them out of a rut that at times filled them with despair. The crop lien, which was a necessity immediately after the civil war, is disappearing where it has not already gone and released the planters from its bondage.

For the first time in nearly half a century the cotton planter's unsecured note is now good at the bank, and his land is a safe security and is salable.

INCREASE IN FARM VALUES.

Such an account of the farms of the United States as is given in the foregoing matter may seem too optimistic in tone and too extravagant in expression. With the expectation that the story of the year would present this appearance, and to verify or discredit it, the Department undertook and has just completed an investigation of the changes in the values per acre of medium farms since the census of 1900. The net result of these changes is an enormous increase in the values, which increase is entirely consonant with the period of high prosperity that the farmers have enjoyed since 1900, the only considerable blot upon an otherwise clean record of these years being the very deficient corn crop of 1901.

Inquiries were addressed to 45,000 correspondents, representing almost every agricultural neighborhood in the United States, and the returns of these correspondents warrant the statements that follow. The values asked for and reported include the buildings and all improvements, but no personal property.

Percentage of gain.—During the five years last past the value of the real estate of medium farms of this country has increased 33.5 per cent, as compared with the census increase of 25 per cent for the real estate of all farms from 1890 to 1900. The highest percentage of increase—40.8 per cent—is found in the South Central group of States. Next to this is 40.2 for the Western group, which includes the Rocky Mountain and Pacific States. Third in order is the South Atlantic group, with 36 per cent of increase. The North Central States, containing most of the great cereal and live-stock surplus region, increased 35.3 per cent, and lowest of all was the increase of the North Atlantic States—13.5 per cent. Thus it appears that the medium farms of the South have increased in value in a greater degree than the medium farms of the entire North as far west as the Rocky Mountains.

Farms are classified according to their principal sources of income, conforming substantially to the census classification for 1900. With this understanding, correspondents report an increase of 46.9 per cent in value per acre for the medium cotton farms during the five years, 35 per cent for the hay and grain farms, 34.3 per cent for the live-stock farms, and 33.2 per cent for the farms devoted principally to sugar cane and sugar beets. Rice farming follows with an increase of 32.2

per cent in value per acre, while close to this is 32.1 per cent for tobacco farms. Next in order are the farms devoted to general farming, with an increase of value per acre amounting to 30.1 per cent, after which are the fruit farms, with an increase of 27.9 per cent; vegetable farms, 26.7 per cent; and, lowest of all, the dairy farms, with an increase of 25.8 per cent.

Dollars of gain per acre.—When a comparison is made among the various regions of the country and among the various classes of farms with regard to the number of dollars of increase, rather than the percentage of increase, the results are very different from the preceding. The medium farms of the North Central division increased on the average $11.25 per acre during the five years. In the Western division of States the increase was $5.36; in the North Atlantic States, $5.26; while the increases were lowest in the South, where in the South Atlantic division the gain was $4.93, and in the South Central, $4.66. The average increase per acre of medium farms in the United States, all classes combined, was $7.31.

Although the rate of increase for cotton farms was highest of all specialized farms, the amount of increase per acre was lowest, or $5.18. Next above this is rice, with $5.97; live stock, with $6.40; and general farming, $6.78. Rising considerably above this was the increase for dairy farms, $8.53; tobacco farms, $9.13; and hay and grain farms, $9.43. The highest increases are for vegetable farms, $11.10; sugar farms, $12.34; and fruit farms, $15.71.

Causes of increase.—While some decreased values were found in a few places, due to local causes, the general fact of large increases in farm values was explained by correspondents with much particularity. The increase is chiefly due to better prices and more profitable results of farm operations, leading to a higher capitalization of land on account of increased net profit. But this by no means fully accounts for the marked increase discovered in farm values, when secondary causes are considered. Everywhere is revealed a more intelligent agriculture; the farmers are improving their cultural methods and are changing from less profitable to more profitable crops. They are discovering that high cost of production attends extensive agriculture, and that, on the contrary, intensive culture and intensive crops increase the net profits per acre. As disclosed in the preceding increases of average acre values, the farms of the less intensive culture and crop have increased in value less than the farms having the more valuable crops receiving high culture.

Other causes for higher values are the erection of new buildings, the keeping of buildings in better repair, better fences, tile draining of land that has been too wet, and a general improvement in farm thrift. New facilities for transportation, where existing, are everywhere reported as at once raising the value of farm lands, whether new railroads or wagon roads that will permit the hauling of larger loads and for longer distances.

Another cause of increase which has had a distinct effect by itself is the growing desire and ability of farmers, and townspeople also, to invest in farm lands as affording a safe investment, even though the rate of interest, as values now are, is not high.

Many minor causes have cooperated with the foregoing to bring about the wonderful increase in farm values during the past five years that the Department has discovered.

Grand aggregate increase of value.—The correspondents reporting with regard to this matter were requested to state increases and decreases for medium farms. There are reasons for believing that the increases for this class of farms may be extended to farms below and above the medium without a material distortion of the fact as representing all farms. While the increases reported for medium farms are higher than for the more poorly kept and less productive farms, on the other hand they are lower than for the better kept and more productive farms of the highest class, which are not covered in the reports of correspondents.

Accepting, then, the increased average acre values of the various classes of medium specialized and general farms as applicable to all farms, including those above and below medium, with such pertinent qualifications as may be made, these increases are applied to the total number of farms of the various classes with results which, it is believed, are approximately correct.

With this understanding it is found that the cotton farms have increased in value $460,000,000, the most prominent increase among the States being Texas, with $115,000,000, while Georgia stands second with $77,000,000, and Mississippi third with $62,000,000. Therefore, it may be said that during the last five years the cotton plantations have had six crops of cotton, one of these crops being a permanent investment and promising to pay a good return year by year.

Sugar farms have increased in value $20,000,000, more than half of which is found in Louisiana and one-sixth in California.

Hay and grain farms have such an immense acreage that the increase for them amounts to $2,000,000,000, three-fourths of which is in the North Central States; and an even greater gain, or $2,263,000,000, was made by the live-stock farms, nearly three-fourths of this also being in the North Central States. In the case of farms having dairying as a specialty the increased value was $369,000,000; tobacco farms increased $57,000,000; rice farms, $3,300,000; fruit, $97,000,000; vegetable farms, $113,000,000; and farms devoted to general and miscellaneous purposes, $768,000,000.

In the grand aggregate of all farms of all classes the increased value equaled the enormous total of $6,133,000,000.

Every sunset during the past five years has registered an increase of $3,400,000 in the value of the farms of this country; every month has piled this value upon value until it has reached $102,000,000; that portion of the National debt bearing interest is equaled by the increased value of farms in nine months, and this increase for a little over a year balances the entire interest and noninterest bearing debt of the United States.

This increased value that has come to farms is invested better than in bank deposits or even in the gilt-edged bonds of private corporations.

ECONOMIC POSITION OF FARMERS.

If the farmers' economic position in the United States is to be condensed to a short paragraph, it may be said that their farms produced this year wealth valued at $6,415,000,000; that farm products are yearly exported with a port value of $875,000,000; that farmers have reversed an adverse international balance of trade, and have been building up one favorable to this country by sending to for-

eign nations a surplus which in sixteen years has aggregated $12,000,000,000, leaving an apparent net balance of trade during that time amounting to $5,092,000,000 after an adverse balance against manufactures and other products not agricultural, amounting to $543,000,000, has been offset. The manufacturing industries that depend upon farm products for raw materials employed 2,154,000 persons in 1900 and used a capital of $4,132,000,000. Within a decade farmers have become prominent as bankers and as money lenders throughout large areas; and during the past five years prosperous conditions and the better-directed efforts of the farmers themselves have increased the value of their farms 33.5 per cent, or an amount approximately equal to $6,133,000,000.

In presenting this the first Annual Report of the third term of the present incumbent of the office of Secretary of Agriculture it has seemed desirable to deviate somewhat from the usual character of this document. As a rule, these reports cover the operations of the Department for a single year, and give considerable space to recording instances of new work undertaken and of partial progress made in the work being carried on. The principal purpose of the present report is to review the work of the Department during the past eight years, and to present for consideration work not only begun but actually accomplished during that period on behalf of the farmer.

WEATHER BUREAU.

SUMMARY OF ACHIEVEMENTS.

The results accomplished by the Weather Bureau for the benefit of the farmer, the mariner, the shipper, the manufacturer, and the seeker after health or pleasure prove that there is no weather service anywhere in the world comparable with it. In recent years it has been equipped with standard instruments, apparatus, and furnishings of the latest design; daily maps are printed at nearly 100 of its local stations; large glass maps, containing the current weather reports, are exhibited each morning before important commercial associations; maps, printed or milleographed, are distributed within three hours from the time that the observations are made. Climatic statistics for the various States are collected from nearly 4,000 voluntary observers using standard instruments, and printed in the form of monthly State bulletins, so that the climate of one region can be readily compared with that of another. It has extended its network of stations around the Caribbean Sea and the Gulf of Mexico, so that no destructive tropical storm may come without warning. It has established stations in Bermuda and in the Bahamas, and arranged for cable cooperation in the Azores and along the western coast of Europe, which enables it to make forecasts for two or three days in advance for steamers leaving this country, and to warn steamers leaving Europe for America of severe storms which they may encounter on their western voyage. With kites and mountain stations it has explored the upper air and gained useful knowledge. It has conducted experiments in wireless, or space, telegraphy, and developed one of the best wireless systems now in use. It has extended its system of telegraphic and climatic observations, so that

that it was not even more so was without question due to the forecast and warning service given by the Weather Bureau.

METEOROLOGY IN SCHOOLS.

The Weather Bureau has encouraged the study of meteorology in educational institutions by allowing its scientists, outside of their official duties, to deliver courses of lectures to students, so that there are now 20 institutions of learning where meteorology forms a part of the curriculum, thereby giving preliminary training to young men who, in after years, may succeed to the duties now performed by the meteorologists of the Government.

At every station of importance occupied by the Weather Bureau it is the custom for the official in charge to deliver such lectures as are desired by the public schools in his immediate neighborhood, and to instruct such classes as visit the offices of the Weather Bureau. In this way a general knowledge of the work of the Bureau is being disseminated in the community. During the past year several hundred such lectures have been given.

BUREAU OF ANIMAL INDUSTRY.

The work of the Bureau of Animal Industry is of great value to the country, and no part of it is of greater importance than the study and investigation of contagious animal diseases with a view to their prevention or control. In the war waged in the interest of stock raisers against contagious diseases the work of the Bureau of Animal Industry has been unremittingly carried on.

BLACKLEG.

In 1897 was begun an investigation for the immediate control of blackleg, or symptomatic anthrax. Losses from this disease were found to be very heavy in Texas, Indian Territory, Oklahoma, Kansas, Nebraska, Colorado, the Dakotas, and it was more or less prevalent in many other States. A series of experiments was made to determine the effect of vaccines, which were finally successful in developing a vaccine efficacious in producing immunity by a single vaccination. The preparation and distribution of this vaccine, with circulars giving methods for using it and containing a full account of the cause and nature of the disease, were undertaken on a large scale. Beginning with 355,000 doses distributed in 1898, the annual distribution was increased until it amounted to nearly 1,750,000 in 1903, with a little reduction since then, the distribution in 1905 amounting to 1,400,000. The effect has been to reduce losses from this disease from 10 to 12 per cent to about one-half of 1 per cent, and recent reports show that the dread disease is rapidly disappearing.

SWINE DISEASES.

In 1897 experiments were made looking to the control of infectious diseases of swine by administering a serum from animals inoculated, respectively, with the hog-cholera and the swine-plague germs. As a result of these experiments and the stamping-out work undertaken in July of that year, 49 entire herds, aggregating 2,904 animals,

had been destroyed and the pens disinfected by the end of the year. This work demonstrated that the losses might be promptly checked by the stamping-out method, but many farmers objected to these measures being carried out, and it was difficult so to enforce the regulations as to prevent the spread of the disease from farm to farm. Continued experiments with the serum treatment showed that there were cases known as hog cholera which did not yield to the treatment, and the very careful work of the Biochemic Division of the Bureau extending over several years has proved that acute hog cholera is caused by a virus which has not yet been cultivated and identified, but which passes through filters which will entirely remove both the hog-cholera and the swine-plague bacilli. The discovery of this hitherto unsuspected contagion has opened up an entirely new field of investigation, which is being energetically developed, and experiments are under progress which, it is hoped, will throw some light upon methods of prevention adapted to this disease.

TEXAS FEVER.

Investigations have been conducted to throw further light upon the microbe organism which causes the Texas fever. It was found that this organism was fostered in the blood of southern animals for as long, in certain cases, as twelve years or more after the removal of the animals from infected districts. It was found, however, that the animal retains its immunity three years after the disappearance of the microbe organism from its blood.

Another point of interest was to determine whether Texas fever ticks were capable of transmitting the disease to susceptible cattle at any time or only when they had recently absorbed blood of cattle from infected districts. It has been found possible to develop ticks in which the power of producing disease is absent. These ticks do not necessarily carry the Texas fever contagion, but obtain the germs of the disease from infected cattle. Other interesting experiments are now being conducted in connection with the subject with a view to acquiring a knowledge which will enable the Department to render more and more efficacious its control of this disease.

SHEEP SCAB.

Sheep scab has been one of the greatest obstacles to successful sheep raising, and the Department has experienced a great deal of difficulty in fighting it. Even after the order of June 18, 1897, was issued diseased sheep continued to arrive in large numbers at the principal markets. In 1898 a bulletin, entitled "Sheep Scab: Its Nature and Treatment," was issued, giving full information upon this subject and specifying the treatment by which the disease might be eradicated. This bulletin had remarkable influence in educating sheep raisers in checking the disease and in informing the public as to a possibility of curing infected animals. In July, 1899, an important order was issued describing the manner in which affected sheep should be dipped, instead of leaving this to the discretion of the owners and commission merchants. This order approved of the tobacco-and-sulphur and the lime-and-sulphur dips; formulas were

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given for their preparation, and the animals had to be dipped in one or the other before they were allowed shipment in interstate commerce.

While this action of the Department specifying dips to be used has been much criticised, it has proved a most important step toward the eradication of sheep scab. The number of sheep dipped under official supervision in 1899 was 672,944. The number increased after the year 1900 by leaps and bounds, nearly 17,000,000 having been dipped in 1905. At the same time it has been found that the dips become more and more efficacious. Reliable returns received in regard to 6,000,000 sheep in 1904 showed an effective percentage of 99.35. It is doubtful if such a measure of success has been achieved in any other country in treating animals for this disease. As the result of this work, sheep scab has almost or quite disappeared from several States that were badly infected and is much less prevalent in most others. By continuing the work and slightly increasing the number of inspectors for a few years it can undoubtedly be eradicated.

MALADIE DU COÏT.

An outbreak of *maladie du coït*, a venereal disease of horses, was discovered in Nebraska in 1898. The disease is a dangerous and insidious one, many of the affected animals showing but very slight symptoms, and yet being capable of transmitting it. While, therefore, in the earlier stages apparently mild, it may be very serious and even fatal, and its existence threatens the horse industry in any section where it gains a foothold. It was important to undertake the suppression of the disease promptly to prevent at any cost its spread to other sections of the country. In 1901 twelve diseased animals were destroyed.

The semiwild condition of the country through which the disease had spread and the prejudices of the horse owners and their lack of cooperation made it a difficult matter to discover diseased animals. Yet in 1902 there were 95 diseased animals slaughtered and 29 diseased stallions castrated. In 1903 there were 16,287 horses inspected, 511 diseased animals slaughtered, 277 suspected animals quarantined, and 1,889 stallions castrated. An order was issued June 20, 1903, prohibiting the transportation of horses from the infected districts unless first inspected by an inspector of the Bureau, and the measures adopted in 1903 continued throughout 1904 and 1905, over 9,000 being inspected in the latter year without finding any actually diseased; also 23 suspected animals were slaughtered, and 9 stallions castrated. It appears from the investigations of the last year that the disease has been practically eradicated.

CATTLE MANGE.

The animals affected by mange were frequently found in important central markets, and accordingly a regulation was issued in June, 1903, prohibiting the shipment from one State to another of affected cattle, and making regulations for the inspection and certification of cattle from the infected districts, and the cleaning and disinfecting of cars. The number of cattle inspected under this order in 1904 was 1,124,321, and the number of dippings exceeded 157,000,

and 535 infected cars were disinfected. The number of horses inspected for mange was 752; 453 were found diseased, and 138 were dipped. In 1905 the number of inspections of cattle was over 14,000,000, the number of dippings 563,394, and 29,897 cars were cleaned and disinfected. There were also inspected for mange 15,971 horses.

FOOT-AND-MOUTH DISEASE.

In the fall of 1902 there occurred an outbreak in New England of the foot-and-mouth disease, and arrangements were at once made with the authorities of the affected States—Massachusetts, Rhode Island, and Vermont—for the eradication of the disease. About 3,000 animals were known to be affected in December; the infected animals were placed under quarantine, a carefully selected force of inspectors organized, and arrangements were made for slaughtering the diseased herds and disinfecting the premises. Owing to the extreme cold and hard freeze, the work of disposing of the carcasses and disinfecting the premises was very difficult. In spite of this, the work was pushed energetically and the spread of the disease was promptly checked. In all, 244 herds, containing 4,712 cattle, were affected; 3,872 cattle were slaughtered, besides a number of hogs, sheep, and goats which had been exposed.

Over $128,000 was paid in compensation for these animals. In the meantime the disease had spread somewhat extensively into New Hampshire, and thorough investigation was made of a considerable part of that State. It was found possible to remove the quarantine May 9, 1903, from Rhode Island, while the port of Boston, which had been closed to the exportation of animals during the outbreak, was reopened July 20, 1903, the quarantine of animals in Massachusetts being removed the following October. It would be impossible to commend too highly the fidelity and energy with which the force of the Bureau carried on the work of eradication in spite of many difficulties. This campaign against a contagious animal disease stands unrivaled, if we consider the celerity, the economy, and the satisfactory results of the work.

TUBERCULOSIS.

Tuberculosis has been studied both as to its effects upon the animal industry of the country and as to the danger of its being communicated from animals to man. It is not uncommon to find herds of dairy cattle where 50 to 90 per cent of the animals are affected with this disease, and in our meat-inspection service there have been found in some large abattoirs nearly 3 per cent of hogs with tuberculosis. The disease, therefore, deserves the most careful study. The studies of the Bureau have been much helped by certain discoveries made by our own employees by which methods of investigation have been greatly improved. Experiments with monkeys showed that these animals are susceptible to both forms of the disease—bovine and human—and that there is little difference to be seen in the results of the infection with either. Careful observations soon indicated that with cattle the disease is more frequently contracted by taking in the bacilli with the inspired air than with the ingested food. A study was made of a herd of 102 cows, 76 of which showed reaction to the

tuberculin test, to determine the infectiveness of milk from cows that had reacted to the test. As a result of this study the following conclusions were reached:

(1) The tubercle bacillus may be demonstrated in milk from tuberculous cows when the udders show no perceptible evidence of disease, either macroscopically or microscopically.

(2) The bacillus of tuberculosis may be excreted from such an udder in sufficient numbers to produce infection in experimental animals both by ingestion and inoculation.

(3) In cows suffering from tuberculosis the udder may, therefore, become affected at any moment.

(4) The presence of the tubercle bacillus in the milk of tuberculous cows is not constant, but varies from day to day.

(5) Cows secreting virulent milk may be affected with tuberculosis to a degree that can be detected only by the tuberculin test.

(6) The physical examination or general appearance of the animal can not fortell the infectiveness of the milk.

(7) The milk of all cows which have reacted to the tuberculin test should be considered as suspicious, and should be subjected to sterilization before using.

(8) Still better, tuberculous cows should not be used for general dairy purposes.

SURRA.

In 1901 a serious disease known as surra was found to exist among horses in the Philippines. Upon the request of the War Department for information on the subject an emergency report on this disease was at once prepared in the Bureau. There is reason to believe that the information thus made available has greatly assisted in the work of repression undertaken in those islands, besides aiding the inspectors of the Bureau in their efforts to keep out animals so infected. On account of this disease the Department has prohibited the landing of any animals from those islands at ports of the United States. Surra is very destructive in its effects on horses, and its introduction into the United States would be a great disaster.

TRICHINOSIS IN GERMANY.

In order to study this subject and to counteract statements continually made by the German press concerning American pork, an employee of the Bureau was sent to Berlin as an attaché of the American embassy to get a correct statement of available records bearing upon the subject. His report, published in 1901, is a clear exposition of the whole matter, and shows conclusively the harmlessness of the American pork shipped to Germany.

MEAT INSPECTION.

The subject of meat inspection grows in importance every year. It is not too much to assert that upon the success of this branch of our work depends a foreign trade worth many millions of dollars yearly to our stock raisers. The meat-inspection law provides for an ante-mortem and a post-mortem inspection. It has increased steadily from year to year. In 1898 the total number of animals

inspected before slaughter aggregated over 51,000,000; over 9,000,000 of them being cattle, 10,000,000 sheep, and 31,000,000 hogs. In 1905 the total number inspected aggregated nearly 66,000,000. At the same time it is important and interesting to know that the increase in the number of animals rejected was much less proportionately than the increase in the number inspected.

In 1898 the number of animals inspected after slaughter was 31,000,000, of which over 4,000,000 were cattle, 5,500,000 sheep, and 21,000,000 hogs. The total number inspected after slaughter in 1905 was something over 40,000,000. There were tagged with the label of inspection in the year 1905 nearly 22,000,000 quarters of beef, nearly 8,000,000 carcasses of mutton, 845,000 carcasses of veal, 1,000,000 carcasses and 800,000 sacks of pork. Meat-inspection stamps indicating the regular post-morten inspection were affixed to 7,000,000 packages of beef in 1905, and to more than 15,000,000 packages of pork. The inspection of cars amounted in 1898 to 18,631, and in 1905 to 66,846. The number of live cattle inspected for export in 1905 was 824,914, of sheep 423,780, and of horses 2,358. In the same year 731 vessels which carried animals for export were inspected. The inspection of live animals at British ports by inspectors of the Bureau included in 1905, 401,623 cattle, 232,925 sheep, and 1,710 horses. Besides these inspections for our export trade, many thousands of inspections were made of imported animals.

NECESSITY OF ADEQUATE APPROPRIATION.

The importance of the cattle and meat inspection work of the Bureau of Animal Industry can not be exaggerated. It is only the certification, under the Government seal of the United States, as to the healthfulness of these products that enables us to place them in foreign markets. The withdrawal or even the restriction of our ability to supply such certification would mean the utter annihilation of our foreign trade in cattle and animal products. At the same time the Department is very much hampered by its inability to meet the demands for inspection for want of adequate appropriations. Requests for inspection—perfectly legitimate and having equal claims upon us with others already conceded—are constantly being received and continually increasing in number, so much so that even if the appropriations asked for for this Bureau last year had been allowed they would still have been inadequate to carry on the work. In the estimates submitted for next year these conditions are provided for, but it is only possible for the Department to carry on this important work adequately by the full compliance of Congress with the estimates submitted for this purpose. If an emergency appropriation be not allowed and made immediately available, the Department will be compelled to abandon a large part of this important work. I deem it impossible to emphasize this situation too strongly.

ANIMAL NUTRITION.

The construction of a respiration calorimeter at Middletown, Conn., by Professors Atwater and Rosa for the study of human nutrition in cooperation with the Department suggested similar work with animals. Work along this line was authorized in June, 1898, to be

conducted by Dr. H. B. Armsby, of the Pennsylvania Experiment Station, and his assistants. The calorimeter was constructed on the plans of the Atwater-Rosa apparatus, specially adapted for use with animals. Experiments were made on the available energy of timothy hay; later, of clover hay and maize meal. The work is now in progress, concluding with a study of the influence of age and individuality on the nutrition of animals.

ANIMAL HUSBANDRY.

An expert in animal husbandry was appointed July 1, 1901, and his attention was chiefly devoted to the investigation of questions of animal husbandry and to the practical or economic side of stock raising. July 1, 1904, an appropriation of $25,000 became available for experiments in animal breeding and feeding in cooperation with the State stations, and this work was placed under the supervision of the expert in animal husbandry. Experiments have been begun in cooperation with the Colorado Experiment Station in breeding American carriage horses; with the Alabama Experiment Station in beef production; with the Maine Experiment Station in poultry breeding, and with the Maryland Experiment Station and the National Zoological Park in breeding zebra hybrids. A study has been begun on the fecundity of Poland China sows, with a view to determining whether sows of this breed have decreased in fecundity, and, if so, whether such decrease is chargeable to particular families. The effect of cotton seed and cotton-seed meal when fed to hogs is also under investigation. Several valuable publications on animal husbandry have already appeared.

ANGORA GOAT INDUSTRY.

The Bureau has aided the establishment of this industry in every way. The goats have been taken into every State and Territory, and reports of their success as mohair producers are numerous.

THE MILCH GOAT INDUSTRY.

Careful investigation of milch goats of European countries have been made and the results printed in a bulletin. The demand for this publication has been large, very many physicians applying for it. During the past year an expert was sent to Europe to investigate the industry in the leading goat countries, and an importation was made of 59 does, 4 bucks, and 5 kids of the Maltese breed. These animals are being employed in cooperation with the experiment stations at Storrs, Conn., and College Park, Md. At the former place cheese making has been undertaken and milk will be supplied to tuberculous patients and to children's hospitals; at the latter, milk will be furnished in Washington, D. C., to be used in the treatment of various diseases.

THE DAIRY INDUSTRY.

Dairying constitutes one of the main branches of animal industry. This line of agricultural effort in the United States yields good returns to a great number of producers. A large amount of capital is

invested in dairying, and the development of the industry has been marked by the intelligence and enterprise of those engaged therein.

The interests of this industry have been looked after by the Dairy Division of the Bureau of Animal Industry. This Division was organized June 30, 1895, and during the past eight years its work has steadily expanded in scope, amount, and importance. At first its efforts were limited to the collection and dissemination of information regarding the dairy industry. Statistics and general information were collected and published; and bulletins were prepared describing the principal breeds of dairy cattle and outlining the most approved methods employed in the several branches of the dairy industry in this country and in Europe.

As time passed and larger funds became available new studies and original investigations were taken up. These included studies and investigations relating to the conditions and demands of domestic and foreign markets; the production of milk and its distribution to the people of cities; imitations of and substitutes for dairy products; and the number and distribution of pure-bred dairy cattle and grades, with their effect upon production and results.

WORK RELATING TO MILK.

Milk, an important product in its new state, and the basis for the manufacture of all other dairy products, has naturally received the first and largest share of attention. Popular bulletins have been prepared and issued in large and repeated editions, the object of which has been to raise the standard of production by educating both the consumers and producers of milk. The most approved methods of feeding, handling, and milking dairy cows, and of cooling, handling, storing, and transporting milk have been presented, and the common errors and dangers involved in careless dairying forcibly pointed out.

WORK RELATING TO BUTTER.

BUTTER EXPORTS.—Experimental exports of butter have received considerable attention. Special agents of the Department have visited Great Britain, France, Germany, China, Japan, and the Philippine Islands and arranged for experimental exports of butter to places in all. Trial shipments have been made to Germany, France, and England. The shipments to Manchester, England, have been most numerous and the most satisfactory, and a good reputation has been established for our butter in that quarter.

COLD STORAGE OF BUTTER.—To determine the best temperature at which to hold butter in storage, experiments were conducted in Chicago in 1903–4. The cream was collected and the butter made by the usual methods of a first-class creamery; the butter was put up in 60-pound tubs and stored at temperatures ranging from 5° F. below zero to 30° above zero. The results proved that a temperature a few degrees below zero is most desirable. The lot stored at 5° below kept almost perfectly for eight months, while the lots stored at 10° and 20° above zero deteriorated greatly.

RENOVATED BUTTER.—To the Dairy Division was assigned the duty of assisting in the administration of the act of Congress approved May 9, 1902, which authorized the Secretary of Agriculture to pro-

vide for inspecting the materials, factories, and processes employed in the manufacture of renovated butter, the object being to insure a sound and wholesome product and to see that renovated butter was labeled and marketed as such. This inspection work was assigned to nine inspectors located in commercial centers. The results have been very satisfactory. The character of the product of renovated-butter factories has been improved, and its price has become steadier; the total product of such factories has increased from 54,500,000 pounds in 1902–3 to 60,000,000 in 1904–5; and the law has not proven in any way detrimental to the makers of country butter, whose product forms the bulk of the stock worked up in such factories. In 1903–4 the inspectors of the Dairy Division reported inspections of 76 factories, and visited the markets in 274 cities located in 44 States and Territories, to investigate and correct the conditions under which the renovated product was marketed. All renovated butter exported is inspected and certified by the dairy inspectors.

WORK RELATING TO CHEESE.

COLD CURING OF CHEESE.—In 1902–3 experiments were carried on in cooperation with the State experiment stations of New York and Wisconsin in the cold curing of cheese. In these experiments about 5½ tons of cheese were used, including all types of American cheese. Cheeses were cured at three temperatures, 40°, 50°, and 60° F. The commercial quality of the cured cheese was tested by a jury of experts. The advantage of curing at low temperature was established. More recently an important experiment has been made in the cold storing of cheese, and the results were quite similar to those secured in the cold-curing experiment.

EXPERIMENT WITH SOFT CHEESE.—An interesting experiment now in progress in cooperation with the agricultural experiment station at Storrs, Conn., relates to the manufacture in this country of soft cheese of the Brie and Camembert types, so largely made in western Europe. About 1,000,000 pounds of this kind of cheese are imported into this country annually.

WORK RELATING TO DAIRY CATTLE.

Realizing that the dairyman's success is so largely dependent on the character of his herd, the Dairy Division has given much attention to dairy cattle and has issued several publications on the subject. The object has been to improve the dairy stock of the country, and two lines of effort promising the largest measure of improvement have been kept continually before those engaged in the industry—(1) the increase of pure-bred stock of recognized dairy breeds, and (2) selection and breeding to secure cows of dairy type.

BUREAU OF PLANT INDUSTRY.

Plant investigations have been a feature of the Department's work since its establishment, although the organization of the Bureau of Plant Industry was not effected till July 1, 1901. It consists now of eleven offices, each of which is charged with the handling of a group

of important plant problems. The work is carried on by 508 employees, about 60 per cent of whom are engaged in scientific work. The work of the Bureau is designed to bear directly on the practical questions which daily confront the tiller of the soil.

PROGRESS IN TREATING PLANT DISEASES.

Extensive investigations have been made in the treatment of plant diseases, with excellent results.

Peach-curl, a disease which occurs wherever the peach is grown, but is especially severe on the Pacific coast, has been brought under control. Experiments on the Pacific coast have resulted during one year alone in a saving of nearly a quarter of a million dollars' worth of fruit.

The little-peach disease, which at one time threatened the orchards of Michigan, New York, and other States, has been studied and its nature and method of control determined. The systematic destruction of the trees, under careful scientific inspection and regulations, is making possible rehabilitation of the peach fruit industry in a number of sections.

Pear blight has received special attention during the past six or eight years. Its nature has been thoroughly determined, and the methods of treatment recommended by the Department are now being followed by large pear growers in a number of parts of the country. Wherever the work of handling the disease is conducted systematically and scientifically, success has followed.

The Department has devoted special attention to the study of diseases of citrus fruits, recognizing the great value of this crop. A method of controlling wither-tip, orange blight, and sooty mold of citrus fruits has been developed and is now in actual use in a number of regions.

The cranberry crop of this country is valued at about $2,000,000. Some years ago the crop was seriously threatened by a disease known as "scald." The Department's investigations resulted in the discovery of the cause of the disease and a method of prevention, thoroughly practicable, which is now in use.

Conservative estimates have placed the annual loss from bitter rot of apples in certain seasons, in the United States, at over $10,000,000. This disease has been successfully treated by spraying. In the past season 90 per cent of the fruit in large orchards was saved, while in adjacent orchards, not treated, the loss was nearly complete.

A number of important crops, such as cabbage, turnips, etc., have from year to year been seriously troubled by certain forms of bacterial diseases. These diseases have been studied, their natures determined, and in most cases remedies developed and put into practical use.

Some destructive diseases of the most important agricultural crops of the South, notably cotton, the cowpea, and the watermelon, have been studied and remedies found for them. One of the most serious diseases of cotton, which for years caused great loss, was wilt. This trouble was especially destructive in the Sea Island districts. Careful scientific investigations showed the cause of the disease to be a

minute fungus working in the roots, and it was further shown that certain plants were able to resist this fungus. Selection of seed from year to year from these plants has resulted in the establishment of resistant types. At the same time that resistance was being developed it was necessary to maintain the value of the types in other directions, notably in lint production, length of fiber, etc. This has all been done.

Cowpeas, which are used extensively in rotation with cotton, are also subject to the same disease, and it therefore became necessary to secure resistant varieties of this crop. This has been accomplished.

The great importance of intensive horticultural work has been fully recognized by the Bureau of Plant Industry in the study of plant diseases. Plants grown under glass are necessarily subject to a number of serious troubles. The Bermuda lily, a very important crop, has for years been subject to a disease which investigations have shown is primarily due to improper methods of cultivation. Methods of avoiding these troubles have been developed by the Department, and in most cases the disease may now be successfully controlled.

Diseases of the violet, the calla lily, the carnation, and other crops have been studied, and important discoveries in reference to their causes and control have been announced.

One of the most important lines of investigation conducted by this Bureau during the past eight years, in cooperation with the Forest Service, has had to do with a study of the decay of construction timber and methods of preventing such decay. This work has resulted in improved methods of handling construction timbers and impregnating them with protective substances. Only recently a cheap and effective method of treating fence posts has been discovered.

Within the past few years a serious disease appearing in the rice fields of South Carolina has threatened a most important industry of the State. Investigations of this disease, made in cooperation with the South Carolina Experiment Station, have resulted in the discovery of the cause of the disease and a comparatively simple remedy therefor.

AGRICULTURAL EXPLORATIONS.

Systematic work in securing new plants and seeds from foreign countries for introduction into the United States was inaugurated in 1897. Remote parts of the world have been searched by agricultural explorers for new crops, and valuable additions to our agricultural productions have been made. The aim of our agricultural explorers has been to seek living seeds and plants in quantity for extensive trial throughout the country. Their explorations have included the desert regions of Asia and Africa, the sub-Arctic regions of Russia, Norway, and Sweden, the climatically east-American regions of China and Japan, the tropical regions of the Dutch East Indies, the Pacific islands and Central America, and the Australian, South American, and South African regions of the southern hemisphere.

Our explorers have brought back large numbers of useful plants, which have been distributed to carefully selected experimenters.

ACHIEVEMENTS IN COTTON BREEDING.

In the breeding and improvement of cotton the first experiments of the Department were begun in 1899. At this time little had been published regarding cotton breeding. Careful methods of breeding were devised and methods of judging cottons by score cards worked out, which have become standards for work in this field of investigation. The frequency of natural crossing in the field was studied, so that different varieties might be grown without risk of mixing and deterioration. The correlation of characters, the laws governing the splitting up of hybrids, the form of plant, and other important matters have been carefully studied. Reliable advice can now be given to cotton seed-growers and breeders.

A most important problem in the cotton industry is the securing of varieties as productive as the ordinary staple sorts but producing longer and better lint. This can be done by two distinctly different methods.

The first method is to secure hybrids of the long-staple Sea Island cotton with the standard short staples, with a view to obtaining new sorts which combine (1) improved length of staple with the large bolls, opening well, and (2) the productive character of plant of the short staple. Many thousands of such hybrids have been made and carefully tested in the course of the Department's experiments, and three new sorts have been secured which possess distinctly valuable characters and are believed to be worthy of general propagation. These have been carefully bred until they are now nearly as uniform in type as the standard varieties, but require to be carefully selected for one or two more generations before they are generally distributed to planters. One of these hybrids, which is a distinctly Upland type of plant and produces large round 5-locked bolls, has fine silky lint from $1\frac{1}{2}$ to $1\frac{5}{8}$ inches in length and a smooth black seed, so that it may be easily ginned on roller gins if desired. The fiber of this variety will rival the Egyptian and lower grades of Sea Island. The other two varieties are similar, but have lint averaging only about $1\frac{3}{8}$ inches.

A second method of securing improved staple, which has given very striking results, is the straight selection of the standard short-staple varieties. It was found by careful examination of such varieties as Russell and Jones Improved, which are both excellent standard sorts, that there was considerable variation in the length of lint produced by different plants. Careful selection experiments have been conducted with both of these varieties, and the average length of lint in the breeding stock of these two varieties has been increased from the ordinary 1 to $1\frac{1}{8}$ inches until it is now from $1\frac{1}{4}$ to $1\frac{3}{8}$ inches; meanwhile the plants have maintained their full productiveness and all other good characters. These varieties, now clearly distinct from the original stock, should be propagated and placed with growers as rapidly as possible. King cotton, which has been so extensively recommended for cultivation in boll-weevil districts, but which has been condemned because of its poor lint qualities, has also shown itself capable of great improvement in the same manner.

All varieties of cotton have been found to vary greatly in their productivity in the case of different individuals and different strains

of the same variety. One strain of Pride of Georgia, which for several years has been selected for increased yield by a careful system of pedigree breeding, has shown marked improvement. A considerable quantity of this seed will be distributed to planters in the spring of 1906, and in 1907 a still higher grade of select seed of the same variety will be available.

In the boll-weevil infested area there is great demand for earlier varieties of big-boll types. The extensive experiments inaugurated in 1904 on this subject have not yet reached a stage where safe conclusions can be drawn, but preliminary experiments started the year preceding have given one very early strain, selected from a native Texas big-boll sort, which has proven very productive and is considerably earlier than the big-boll sorts with which it has been compared. A limited trial distribution of the seed of this variety will be made in the spring of 1906.

A large quantity of Egyptian cotton is imported into this country annually and used in our mills. It seemed probable that with our extensive cotton area some soil and climate could be found where this cotton could be successfully grown. Experiments were conducted in various parts of the country and careful manufacturing tests were made with the fiber. These experiments have shown conclusively that we can in many places produce an excellent quality of fiber, possessing all the characteristics of the best Egyptian-grown fiber. The yield in most places, however, has been so low that these cottons can not compete with the ordinary Uplands. If they are to succeed, more productive and earlier sorts will have to be bred, or the cultivation will have to be conducted in the extreme southern part of the cotton belt, where there is a very long growing season.

MEETING THE RAVAGES OF THE COTTON BOLL WEEVIL.

As the spread of the cotton boll weevil extended north and east in Texas it became evident that there were problems connected with the invasion of this pest other than those purely entomological. The invasion of the weevil necessitated, in many cases, a complete revolution in agricultural practices. The Bureau of Plant Industry, in order to meet this exigency, has had for the past two years a corps of workers in the field carrying on important investigations in the matter of breeding new types of cotton better adapted to the conditions which have arisen since the invasion of the weevil. It has been conducting demonstration work to point out and emphasize the value of the discoveries which have been made by the Bureau of Entomology and other branches of the Department and to encourage diversification of crops. It has been searching the cotton regions of this and other countries in the hope of discovering types of cotton better suited to the new conditions in the invaded territory. In connection with this work some important discoveries have been made in the matter of types of cotton which have, through a long series of years, been able to adapt themselves to the presence of the weevil.

The most important work, however, in this connection, has been the field demonstration work which has had for its object the bringing home to the people themselves practical methods of tillage, cultivation, and planting to enable them to grow cotton despite the presence

of the weevil. This general demonstration work has been pushed energetically in Texas and also extended into Louisiana in advance of the insect.

NEW CITRUS FRUITS PRODUCED BY THE DEPARTMENT.

The two great freezes of the winter of 1894 and 1895, which killed to the ground practically every orange and lemon tree in Florida except in the extreme southern part of the State, served to emphasize the great importance of securing hardy varieties of these fruits. Experiments were started by the Department, and the results which have been obtained are very valuable and encouraging. It has been shown that valuable hardy races can be produced by crossing the very hardy cold-resisting trifoliate orange with the different varieties of the ordinary sweet orange. Two of these hybrids which were found to produce valuable fruits were propagated, and in the spring of 1905 distributed broadcast to interested growers in South Carolina, Georgia, Alabama, Louisiana, southern Tennessee and Arkansas, eastern and southern Texas, and regions of low altitude in Arizona, New Mexico, Washington, and Oregon. These fruits, being different from any known group of citrus fruits, were named citranges, and the two varieties distributed were named, respectively, the "Rusk" and the "Willits."

Four other varieties of hardy oranges, or citranges, have been obtained, each possessing special features of merit. One of these produces a fruit so similar in size and appearance to the ordinary orange that it can only be distinguished by an expert. This fruit has been named the Morton.

Another variety, similar to the Morton in appearance, but differing in flavor and tree characters, is also believed to be valuable and will be propagated for distribution as soon as possible.

A special feature of these hybrids is their fine foliage characters, which adapt them to propagation as lawn trees and as hedge plants. Some of the hybrid oranges are far superior in general adaptability to the trifoliate oranges often grown for this purpose, having much denser and handsomer foliage, and being largely evergreen, retaining the greater part of their foliage throughout the winter. The Rusk and Willits citranges and the two varieties last mentioned, however, are hardly satisfactory to use for general hedge purposes, as they are nearly seedless and would require to be propagated by budding. Fortunately, two hybrids have been secured which have the desirable hedge characters and have thus far produced an abundance of seeds, indicating that they will be very desirable for use in this way. These two varieties will be tested as hedge plants and distributed if they continue to form numerous seeds, which will allow of their easy and cheap propagation.

In the course of the experiments two new tangerines have been produced, which have been named the "Weshart" and the "Trimble." These produce fruits considerably larger than the ordinary tangerine and are nearly two weeks earlier in season—two very desirable characters. These varieties have been propagated as rapidly as possible, and a limited distribution of budded trees will be made.

One of the most interesting of the Department's productions is the new tangelo. This fruit, a hybrid of the pomelo with the tangerine,

may be described as a small, loose-skinned ("kid-glove") pomelo. It has a good sprightly acid flavor, which it is believed will render it a popular fruit. It has been named the "Sampson," and a limited distribution of stock will be made next spring.

One very excellent variety of sweet orange has been secured, which will probably be propagated and introduced. It is a large, round blood orange, nearly seedless.

NEW PINEAPPLES PRODUCED BY THE DEPARTMENT.

The so-called fancy varieties of pineapples grown and tested in the United States have as a whole proved unsatisfactory, so that their cultivation has been largely abandoned for the cultivation of the inferior but more robust and hardy varieties, such as the Red Spanish. It is thus desirable that varieties of better fruit qualities be secured, which at the same time will have a vigorous, hardy constitution, adapting them to general cultivation. To secure such improved sorts many hybrids have been made by the Department, the experiments having been started mainly in 1896 and 1897. These have as a whole produced fruits of exceptionally good quality.

WORK ON NITROGEN FIXATION.

The great value of leguminous crops for forage and as soil improvers, especially in their ability under certain conditions to fix atmospheric nitrogen, led this Department in 1899 to undertake a study of the Old World legumes with a view to introducing into the United States such as promised to be valuable in regions not now well supplied with these crops. Early in this work it became evident that we must also introduce the tubercle bacteria, especially for those species of legumes not having closely related species in cultivation in the United States. During the following three years a large number of introductions of these crops was made, and in all cases where it seemed desirable root samples containing tubercles were also secured. The isolation and distribution of these nodule-forming bacteria, with their appropriate crops, was believed to be one of the prime factors in their successful introduction. The common practice of inoculating leguminous crops by the use of soil which was known to contain the proper bacteria was not only expensive, especially where the soil had to be transported for long distances, but was fraught with great danger of introducing noxious weeds, plant diseases, and insects. An investigation was therefore made of the method proposed by Nobbe and Hiltner, of Germany, for inoculation by the use of pure cultures under the name of "nitragin." It was found that these cultures had been tested very carefully in this country and in Europe and had proven unsatisfactory.

In the course of the investigations, moreover, it was soon found that the pure-culture method, as then practiced, was a failure, owing to the fact that the bacteria were cultivated artificially on a substratum rich in nitrogen, thus obtaining all of the nitrogen they desired for growth direct from their food supply without depending upon the atmosphere for it. It was found that as soon as the nitrogen was removed and the bacteria were required to depend upon the atmosphere for their supply of nitrogen it was possible to secure strains

of bacteria with greatly increased nitrogen-fixing power. It was further found that these bacteria thus secured could be dried on an absorbent medium like cotton, retaining their vitality undiminished.

Extensive tests of this method of culture and distribution were made in the laboratory and field during 1902 and 1903. These tests under careful scientific control were so successful and the method was simplified so greatly that it seemed desirable to give it a careful test in the hands of practical farmers. It was believed that a method to be of any value should be simple enough to be used by an intelligent farmer. As a result of a general distribution of cultures in the latter part of 1903 and in the spring of 1904, it is evident that the method of distribution perfected by the Department has great advantages over any other method of soil inoculation yet devised. While there is much yet to be done in determining the conditions under which the use of these tubercle-forming bacteria will give the most favorable results, it is evident that we have a very successful method of growing and distributing them and increasing their nitrogen-fixing powers. No new development of this kind can be successful in the hands of everybody. Failure may come from many causes. Usually these causes are easily determined and corrected. Sometimes they are obscure and must be carefully investigated in order to be determined. On the whole, however, the intelligent farmer is able to use the cultures under favorable conditions with success and profit.

WORK ON WATER CONTAMINATION.

In 1902, under authority from Congress, this Department began an investigation of algal and bacterial contaminations of water supplies. Some preliminary tests made in 1901 in removing algæ from cress beds were so successful that it seemed desirable to test the method under a wider range of conditions. Although sand filtration in the case of water supplies for domestic use had proved successful in removing bacterial contamination, it failed completely in the matter of algal organisms that give disagreeable tastes and odors to water in which the algæ occur. Extensive tests were made in the laboratory during 1902 and 1903, and also in large reservoirs and other water supplies in various parts of the country. The results of these tests were first published in May, 1904. In this report it was shown that minute traces of copper, so small as to be entirely harmless to man and to the higher animals (and even to fish, if properly used), would successfully destroy not only contaminating algæ but also bacteria of the typhoid and cholera groups. The method has been further tested in cooperation with boards of health and water engineers in many parts of the country during the past two years, and in nearly every case where the work has been done according to directions of the Department it has resulted successfully. Many intelligent boards of health and water engineers are recognizing the value of the method when used under proper conditions.

ADVANCES IN GRASS AND FORAGE PLANT INVESTIGATIONS.

The Department has made considerable progress in grass and forage plant investigations. Largely through its efforts, alfalfa has been thoroughly established in almost every State, including the Eastern

States. The new Turkestan variety, introduced by our explorers, has proved to be of special value for the Northwest and other cold, dry sections.

Methods of restoring denuded ranges and maintaining a productive condition have been worked out. Several spineless varieties of cactus have been introduced from Mexico, the value of this plant as a forage crop having been demonstrated.

It has been found possible to control drifting sand by vegetation, and valuable results have been secured in covering railroad embankments and cuts with plant growth.

Cowpeas, soy beans, and new varieties of sorghum have all been effectively studied, and their growth extended. Several new varieties have been studied, and their value for hay and pasture demonstrated. A number of wild grasses have been introduced into cultivation. As a winter pasture and forage for the South the hairy vetch has assumed importance. A cheap and complete method of eradicating Johnson grass, which is probably the worst weed in the United States, has been worked out.

BETTER SEEDS FOR THE FARMER.

Methods and apparatus for testing seeds for mechanical purity and germination have been studied and perfected. By means of publications giving descriptions and drawings of weed seeds and the seed of our economic plants, farmers have been warned of the adulterants frequently found in field seeds and have been advised as to the general quality of those in the trade. They have been invited, in all cases of doubt, to submit samples to the Department for testing before buying.

Through samples of imported seed received from the custom-houses, information has been obtained as to the quality and kinds of seed being imported both for legitimate use and for purposes of adulteration.

The proper conditions for the storage of seeds under unfavorable climatic conditions have been determined. The handling of Kentucky bluegrass has been studied and the proper treatment to economically produce seed of high vitality has been pointed out.

IMPORTANT RESULTS IN GRAIN INVESTIGATIONS.

DURUM WHEAT.—Durum wheat was first introduced from east and south Russia in the spring of 1899. During the next year a much larger quantity of seed was imported, including varieties from North Africa. In 1901 there were produced probably 50,000 bushels of durum wheat. The following year there appear to have been grown considerably over 1,000,000 bushels. The production has steadily increased until in the season of 1905 it is conservatively estimated by grain dealers to be between twelve and fifteen million bushels for the three States of North Dakota, South Dakota, and Minnesota. Add to this about 5,000,000 bushels for Kansas, Nebraska, Colorado, and the Rocky Mountain and Pacific Coast States, and the result is a production of probably 20,000,000 bushels for the entire country.

It is reported that during October about 6,000,000 bushels of

durum wheat were shipped to Europe and that the prices recently offered by importers were an advance of 12 cents over the price paid for the first shipments. The question of marketing the wheat, therefore, can no longer be a doubtful one, as our reputation for furnishing a good quality of grain is well established. As stated recently by an official of the board of trade of Duluth, durum wheat has "passed the experimental stage and is now a regular commodity."

SWEDISH SELECT OAT.—Another valuable new crop is a variety of oat known as "Swedish Select," introduced in the spring of 1899. This oat is a pedigreed variety, developed many years ago in Sweden and afterward thoroughly acclimated in the cold region of northern Russia. It is admirably adapted to our Northern States, and long ago became the most popular oat throughout the region from Wisconsin to Montana.

SIXTY-DAY OAT.—This variety of oat was introduced from southwestern Russia four years ago, and is now giving results in the territory of the Middle West comparable to those obtained with the Swedish Select in the North. Being much earlier than ordinary oats, it is able to escape rust and other fungous and insect pests in seasons when other varieties are badly affected. For the same reason it also sometimes escapes the worst stage of a drought.

EXTENSION OF THE WINTER-GRAIN AREA.—One of the most important things in grain cultivation is to be able to grow fall-sown crops, as both the yield and quality of a winter grain are invariably better than those of spring grain in the same locality. A valuable achievement of the Department in this line is the successful introduction of winter barley, known as "Tennessee Winter," into northern latitudes. This barley is now thoroughly acclimated as far north as Kansas and gives yields so much greater than those of spring barleys and is so important on certain occasions for winter pasturage that it is causing little less than a revolution in grain cultivation in a number of localities.

Two Algerian barleys have been introduced with much success in the Southwest. They are thoroughly adapted to desert conditions and alkali soils and have so far given yields per acre that are from 50 to 80 per cent greater than those of other varieties in the region between Texas and southern California.

In the grain experiments carried on in cooperation with the Maryland Experiment Station it has been discovered that there are a number of important varieties of two-rowed hull-less and other kinds of barleys that are perfectly hardy when sown in the fall.

The winter-wheat area is being extended north and west, largely through the introduction of the Kharkof winter wheat, which has become almost as popular as the Swedish Select oat. It is closely allied to the well-known Kansas Turkey wheat, but is hardier both for the winter and in seasons of drought. The winter-wheat area has already been extended almost entirely over the State of Nebraska, to a considerable extent in Minnesota, and to a lesser extent in South Dakota.

ENCOURAGEMENT OF RICE PRODUCTION.

Rice has received special attention during the past six or seven years. The Japanese, or Kiushu, variety was brought into the country

and disseminated. Since this introduction the development of the rice industry in the South has been phenomenal. Between 1899 and 1904 the rice acreage of Louisiana and Texas increased from 210,396 acres, yielding 179,919,293 pounds of rough rice, in 1899 to 610,700 acres in 1904, yielding 869,426,800 pounds, an increase of upward of 190 per cent in acreage, by far the greater increase being in Texas. In 1889 Texas had 178 acres of rice, in 1899, 8,711 acres, while in 1904 the acreage had increased to 376,500, or more than forty-three times the area under this crop six years ago.

PROGRESS IN THE BEET-SUGAR INDUSTRY.

In 1897 there were but nine beet-sugar factories in the country, and the total amount of sugar manufactured was 30,000 short tons. A great change has since taken place, and the estimated output for 1905 is 280,000 short tons.

Extensive practical demonstrations carried on throughout the sugar-beet belt have clearly and positively proved that if the farmers will properly prepare and fertilize the soil, sow a high grade of seed, cultivate and care for the growing crop, and treat it for diseases and insects in accordance with the methods recommended by the Department, not only will their yield be increased but their beets will be of better quality and higher sugar content, while the cost of their production will be materially decreased.

The failure of more than one factory has been due to the use of poor seed, and the establishment of high grades of seed has been one of the most difficult problems with which we have had to contend. The Department has, however, within the last year or two, succeeded in establishing farms in sections of the United States where the climate and soil conditions are favorable for the supply of pedigreed seed of superior quality.

Last year one of the largest growers of this seed had to refuse more than 50 per cent of his orders on account of his inability to grow a sufficient quantity of seed. These results warrant the assertion that within the next few years the quantity of seed grown in the United States will not only greatly exceed that grown heretofore, but by its use beet-sugar factories will greatly increase their percentage of sugar extraction. The fact that an increase of 1 per cent in the sugar extraction for last year would have increased the output of refined sugar by more than 40,000,000 pounds is in itself sufficient reason to warrant the Department in exerting every energy to continue the encouragement and assistance it has given to sugar-beet seed growers.

The work the Department has undertaken in establishing single-germ beet seed has proved eminently satisfactory, and it is now assured that a high-grade strain of single-germ seed can be produced, which will greatly reduce the cost of thinning. This will mean the saving of thousands of dollars to farmers throughout the sugar-beet belt, and will give a new impetus to sugar-beet growing.

The yield of sugar beets has been greatly increased not only by scientific cultivation, but by the judicious use of fertilizers, which in some cases have increased the yield from 40 to 50 per cent, and at the same time improved the quality of the beets.

RECENTLY ESTABLISHED FACTS IN TROPICAL AGRICULTURE.

A special branch of the Bureau of Plant Industry has devoted a large part of its attention to various crops suitable for the Tropics.

Coffee has received special study in Porto Rico. Studies of coffee in other regions have been made with a view to profiting by the results obtained in those regions. Several of the supposed principles of coffee culture have been found, on being subjected to scientific study, to have only local application. It has been shown that the value of shade, which is recognized in a number of coffee-growing sections, is due primarily to the fact that the shade trees are of the leguminous family.

Important investigations have been made of the rubber industry in Central America. These studies have developed two important facts: First, that the rubber tree does not require to be grown in regions of great and continuous humidity, as heretofore believed, but thrives and produces better in districts subject to a distinct dry season. The second important fact is that, contrary to previous popular and scientific opinion, the same species of rubber does not extend throughout the Central American region. The reports which the Department has published have served as a warning to the public of the essentially uncertain character of a number of undertakings in rubber culture and have undoubtedly saved to the American public millions of dollars.

Cacao is another crop which has received special study. The cultivation of this crop is confined almost entirely to humid localities, in accordance with the belief that such a climate is necessary to the welfare of the tree. This belief is erroneous, and it is expected that with better cultural methods the growing of this important crop will become an established industry in all the tropical possessions of the United States.

Millions of dollars are paid annually by this country for tropical products grown outside of our territory. The efforts of the Department have been in the direction of encouraging the production of these crops, as already indicated, in our own tropical dependencies.

ADVANCES IN POMOLOGICAL INVESTIGATIONS.

Along the line of pomological work much of immediate practical value to fruit growers and handlers has been accomplished. Thousands of specimens of fruits forwarded by growers for identification have been passed upon by the pomologist and his expert assistants.

A fairly comprehensive test of a large number of Vinifera grapes on resistant stocks in North Carolina and Florida has demonstrated that certain choice sorts of this type hitherto considered impossible of cultivation in the open air in the South Atlantic States can be successfully grown for home use, at least, when grafted upon such stocks and when thoroughly sprayed to protect against fungous diseases. A systematic and comprehensive experimental investigation of the relative adaptability of resistant stocks to the various soil types of the Pacific slope and of the relative congeniality of the important commercial Vinifera varieties to these stocks is in progress in California. The continued prosperity of the viticultural industry of the Pacific coast, in which over $85,000,000 is now invested,

depends in large degree upon the accurate determination of these important questions.

In recognition of the fact that the avoidance of disastrous gluts in our markets is one of the most important factors in developing and maintaining a thrifty fruit industry, special attention has for several years been paid to the encouragement of export trade in American fruits and the improvement of methods and practice in fruit storage and transportation. Comprehensive experimental investigations to determine the best methods of harvesting, packing, handling, and transporting such fruits as are most promising for export have been conducted. Through cooperative experimental export shipments during the last four seasons it has been demonstrated that eastern-grown "Bartlett" pears can be successfully and profitably exported in seasons when the European crop situation justifies the effort.

A large and rapidly developing export trade in eastern-grown "Bartlett" and other autumn pears has developed along the lines pointed out by these experiments. It has been further demonstrated that early varieties of apples from the Middle Atlantic States can be delivered in British markets in excellent condition when proper precautions as to harvesting, packing, and forwarding are observed; also that "Elberta" peaches from Georgia, Oklahoma, and Connecticut, and later varieties of this fruit from the mountain orchards of Virginia and West Virginia, can be delivered in the United Kingdom in sound and attractive condition whenever the market conditions warrant. It is believed that the establishment of these facts has laid the foundation for a normal and thrifty development of a profitable future export trade in these fruits.

When the Bureau of Plant Industry began the fruit transportation and storage investigations there was little exact information concerning the factors that influence the shipping and keeping qualities of fruits. Very serious losses occur in transit in small fruits and in fruits such as the peach and the orange, as well as in fruit in cold storage. It has not been known whether these losses are due to the cultural treatment, to the methods of handling the fruit, or to the conditions surrounding the fruit in transit and in warehouses. There have been much litigation and many misunderstandings over these difficulties. The Bureau of Plant Industry has succeeded in establishing some of the fundamental factors that govern these questions. It has applied the results to the commercial fruit business of the country in such a way that it has been a distinct benefit to the grower, the shipper, the warehouseman, and the transportation companies.

It has been determined that fruit is not likely to keep well if it is forced to growth. The apple handler has been told to watch the fruit more carefully and sell it relatively early in the season if it has been grown on rank-growing young trees. It has been demonstrated that the apple scald, one of the worst troubles with some varieties in cold storage, can be practically controlled by letting the fruit reach the stage of hard ripeness on the tree, by storing it quickly after picking in a temperature not above 32° F., and by selling relatively early in the season the varieties that are likely to scald. A large proportion of the losses from decay in the transportation and storage of fruit

such as the apple and the orange is the result of breaking the skin, thereby making the fruit susceptible to the attacks of the common mold. Fruit is injured by rough handling to a far greater extent than the most experienced fruit growers and shippers have supposed. We have gone into the field and have shown how these injuries occur. Extensive shipping experiments have shown that the losses in injured fruit may be very heavy in transit and in storage, while perfect fruit of the same varieties may be transported or kept in storage in sound condition. It has been clearly proved that the delays that commonly occur in shipping and storing the fruit in warm weather cause the decays and the ripening processes to develop prematurely, and, in connection with improper handling, cause a large proportion of the storage and transportation losses.

The Bureau has demonstrated that the ripening processes and the development of rots must be checked by cooling the fruit as soon as it is picked. Quick-ripening fruits, like "Bartlett" pears, do not cool quickly enough in the center of a barrel when placed in cold storage, and such fruits should be stored in small packages; fruit that is to be stored several months should be packed in closed packages to prevent it from shriveling; a wrapper lengthens the storage period, and a temperature as low as 32° F. keeps apples of all varieties, pears, peaches, and small fruits longer and in better condition than a higher temperature. It has been shown also that the losses from the ripening of fruit in the top of a refrigerator car may be reduced to an important extent by cooling it quickly, after picking, to a temperature of 35° to 40° F., and, further, that a refrigerator car, kept well iced, will maintain such a uniform temperature if the fruit is first reduced to that degree of cold. These investigations are having an important influence on improving the methods of conducting the fruit industry of the United States.

DRUG AND POISONOUS PLANT INVESTIGATIONS.

In the drug-plant investigations a field study of small areas of many kinds of drug-producing plants has been made in Vermont, in the District of Columbia, and in South Carolina, and it has been shown that many of the most important kinds will do well, e. g., poppy, belladonna, digitalis, wormwood, peppermint, etc. Curing processes have been studied and some of the most important features worked out. A method of utilizing the poppy plant or its parts as a crude source for morphine has been developed on a laboratory scale, and through the Office of Seed and Plant Introduction, a larger test of the commercial possibilities is planned. The production of camphor and licorice is being studied. Distillations from Florida camphor plantations have given a good yield of crude gum camphor. The production of camphor on a commercial scale will be tested in the near future. Certain important wild drug plants threatened with extermination have been successfully brought under cultivation. The utilization of weeds used in medicine has received some attention as a source of profit.

The object of poisonous-plant investigations is to study the relation of stock losses to the eating of poisonous plants. Extensive field studies, especially in Montana and other Western States, have shown

that great and often sudden losses are not infrequently due to the eating of harmful plants growing on the range. The chronic trouble known as "loco disease" is now under study.

TEA-CULTURE INVESTIGATIONS.

In conducting experiments in the cultivation of tea in the South it has been demonstrated that the most important varieties of the tea plant, that from Ceylon excepted, make a growth and give a yield comparing very favorably with the results produced in their own lands. It has also been shown that negro children make expert tea pickers when properly trained. Several new and valuable machines have been invented: (1) A rotary sterilizing machine for withering the leaf to be made into green tea; (2) an attritionizer which at minimum cost polishes the tea, thus enhancing its appearance and market value. A new type of rolling machine is now being perfected to give a better "roll" to the tea than is given by the machines now in use.

Twenty-five acres of tea have been planted at Pierce, Tex., and a preliminary plucking indicates that a very high grade of tea will probably be produced. During the past season 9,000 pounds of tea were made at Summerville, S. C.

IMPROVEMENTS IN SEED DISTRIBUTION.

One of the most important tasks which the Department has to perform is the securing and distribution of the large quantity of seeds made necessary by the Congressional seed distribution. In the earlier work of the Department it was the practice to secure this seed, put it up, and send it out entirely with a departmental force. As the demand for seed increased and the work grew, it was found difficult to handle the complicated questions involved in this way. For a time the handling of the seed for the Congressional distribution was placed in the hands of contractors, but this was found unsatisfactory.

The Bureau of Plant Industry was charged with all matters pertaining to the seed work, and for the past four years has been giving special attention to improvements in the methods of securing, handling, and distributing. The Department has made a special effort to secure home-grown seed from growers and dealers in the United States.

A special effort has been made in the matter of encouraging bulb culture. While the actual number of miscellaneous vegetable seeds distributed has increased, the cost of the work has been diminished and the saving effected thereby has been devoted to the purchase, distribution, and encouragement of the use of improved seeds of various kinds. A special feature has been made of encouraging school garden work through the seed distribution. Formerly it was the practice to send the same kind of seeds to the cities as was sent to the country districts. Now special arrangements have been made for placing in the hands of Senators and Members of Congress who have city constituents seeds especially designed for encouraging garden work in the public schools. Circulars of instruction have been prepared and issued with these seeds. Special attention has also been given to the securing and distribution of improved forage-crop seed, cotton seed, and other seeds.

FARM-MANAGEMENT WORK.

The Office of Farm Management has been developed in the Department during the past four years. Until recently its most important work has consisted in the study of farm practice. This study has resulted in finding many farmers who are preeminently successful in their chosen occupation. A careful study of their methods has been made. It has been completely demonstrated that preeminent success in farming consists in combining scientific knowledge with business methods. The publication of the results of these studies has aroused among farmers great interest in agricultural science. Some farmers who are following closely the teachings of agricultural science have been found who regularly secure a net income greater than the price of good farm land in this country.

As a result of the study of farm practice and of scientific investigation, it has been possible to establish object-lesson farms in various parts of the country, and 35 such farms are now in operation. The results obtained on these farms have surpassed expectations. On one dairy farm in the South the net income was doubled in one year. In another instance, a cotton farm with a net profit of $5 per acre was converted into a hay and stock farm with net profits three times the value of the land when work upon it was begun by the Department.

FOREST SERVICE.

During the past year the Government work in forestry entered upon a new phase. Practical work in the actual introduction of forestry began in 1898, but it was not until February 1, 1905, when the care of the National forest reserves was transferred to the Department of Agriculture, that the Forest Service became an administrative organization.

This transfer was a logical outcome of the recent work of the Service. During the last six or seven years it has passed through a remarkable development, which has followed but not kept pace with its demonstration of capacity for public usefulness. On July 1, 1898, the Division of Forestry employed eleven persons, of whom six filled clerical or other subordinate positions, and five belonged to the scientific staff. Of the latter, two were professional foresters. The Division possessed no field equipment; practically all of its work was office work.

At the opening of the present fiscal year the employees of the Forest Service numbered 821, of whom 153 were professional trained foresters. Field work was going on in 27 States and Territories, from the Atlantic to the Pacific and from Canada to Mexico. Over 900,000 acres of private forest were under management recommended by the Service, and applications on file for advice from owners contemplating management covered 2,000,000 acres more. During the year nearly 62,000 letters were sent out from the offices at Washington, the majority of them in reply to requests for information and advice from the public, of a kind which could not be met by printed information.

This contrast imperfectly indicates the full extent of the change which has taken place, and the progress which has been made. Seven

years ago there were in the whole United States less than ten professional foresters. Neither a science nor a literature of American forestry was in existence, nor could an education in the subject be obtained in this country.

The real need of forestry was urgent. A time had come which presented at once a great opportunity and a dangerous crisis. Forest destruction had reached a point where sagacious men—most of all, sagacious lumbermen—could plainly discern the not distant end. The lumber industry, vital to the Nation at large, was rushing to its own extinction, yet with no avenue of escape apparent until forest management for future crops should be forced by famine prices. Meanwhile, however, the ruin would have been wrought already.

Timber-land owners were selling their holdings or their stumpage with little evidence of an understanding of their future value, and lumbermen were compelled by business competition to keep down the cost of operation to the lowest terms or market their product at a loss.

Forestry was both an evident economic need and an apparent economic impossibility. Few well-informed persons believed that the obstacles to its introduction could be overcome sufficiently to bring it into common practice among private owners during the lives of the present generation.

That the whole situation is profoundly altered is directly and chiefly due to the work of the Forest Service. With its offer of practical assistance to forest owners made in the fall of 1898, its field of action shifted from the desk to the woods. The lumberman was met on his own ground. Uncertain speculations were converted into business propositions and untried theories into practical rules. Actual management for purely commercial ends has been taken up and applied on their own holdings by some of the best known lumbermen in the country. What lumbermen as a body now think of forestry is illustrated by the recent effective movement in their National association to endow a chair of lumbering at one of the forest schools.

Forestry is a matter of immediate interest to every household in the land. Forest destruction is no imaginary danger of a distant future. If it is not speedily checked its effects will sooner or later be felt in every industry and every home. To make these facts known is a National duty. The work of education must continue until public opinion will not tolerate heedless waste or injudicious laws.

PRESENT STANDING OF FORESTRY.

The period which has passed since 1898 has been, in forest work, a period of large definite accomplishments and of effective preparation for the future. Of the exact knowledge concerning our American forests, upon which the practice of scientific forestry depends, vastly more has been gathered during the last seven years than previously from the time Columbus landed. In 1898 the Division of Forestry had hardly approached the specific problems of forest management in the United States, and had developed no efficient methods of attacking them. The records now on file are based on the measurements of millions of individual trees. Commercial tree studies looking toward management have been prosecuted for 32 important species. Working plans have been prepared in 28 States,

and field work has been conducted in every State and Territory in the United States, and in Porto Rico, Alaska, and the Philippines.

The scientific knowledge gathered in the field has taken form in a rapidly growing literature of the subject, and has furnished the basis for a system of professional education. To-day there is scarcely more occasion for the American to go abroad to study forestry than to study medicine or law.

Besides creating a science of American forestry, the Forest Service has worked out the methods of operation by which forestry may be put in practice. It found in existence a fully developed system of lumbering, which had brought efficiency and economy of labor to the highest point, but was often wasteful of material and regarded forests as simply so much standing timber to be cut. Men taught to regard cheap logs at the mill as the supreme test and sole end of good lumbering, justly proud of their proficiency in a highly specialized industry, and impatient of restraint, could not be expected to welcome with cordiality changes for a purpose whose utility they were necessarily slow to recognize. To work a reform it was necessary to begin with existing conditions and improve them instead of criticising them. Had not the Forest Service taken the lead in finding out just how practical rules for conservative lumbering might be laid down and carried out, forestry could not have reached the point at which it now stands in the United States.

In the field of economic tree planting the same story is repeated and shows definite, important, and permanent results. It is true that in 1898 farmers throughout the Middle West, where tree planting finds its largest field of economic usefulness, were already alive to their need of planted timber. But the knowledge of what kinds of trees to plant and how to make them grow was imperfect. These were the fundamental problems: (1) The comparative adaptability of various species to regional and local conditions of climate, soil, and moisture; (2) the comparative usefulness of the species which can be made to thrive; (3) the protective benefits of planted timber; and, (4) the rate of growth and the future yield which can be expected.

Substantial progress toward the solution of all of these problems has been accomplished. The Forest Service has made in all 300 separate planting plans for private owners, covering an aggregate area of over 50,000 acres, in 36 States and Territories. It has completed regional studies of the broad conditions in the New England States, California, Kansas, Nebraska, Iowa, eastern South Dakota, western Minnesota, Illinois, Oklahoma, and the Ohio Basin in Ohio, Pennsylvania, and West Virginia. These studies largely supersede the necessity of future individual studies on the ground. It is now in a position to exercise great helpfulness in the whole planting movement throughout the United States. It has established in the minds of western farmers generally the fact that tree planting can be made successful and that it adds to the money value of their farms. It has also called attention to the great hygienic importance of tree planting on the watersheds; of public water supplies of cities, east and west; has developed practical methods for reforesting denuded mountain slopes and for establishing new forest growth in regions of little rainfall, and has powerfully contributed to the great work of reclaiming desert lands through water conservation and to the whole irrigation movement.

THE GAIN IN ECONOMY OF USE.

The Forest Service has in the last seven years added greatly to our visible forest resources. In the saving of waste it has enriched the country by many millions of dollars, and in this way alone has added vastly more to the National wealth than its total expenditures for all purposes during its entire history.

Its most important achievements in decreasing the drain upon our forests by providing for their more effective utilization have been along four lines—determination of the strength of different kinds of timber, studies of methods by which timber may be made more durable, efforts to decrease waste in lumbering, and the discovery and introduction of better methods of gathering forest products other than lumber.

By its timber tests the Forest Service has established the suitability of various little-used but abundant woods, especially for structural uses, and has made possible the more economical use of other woods by an exact determination of their strength. By its studies of the effects of seasoning and the value of different methods of preservative treatment, it has opened the way to an enormous reduction in the drain upon our forests for railroad ties. What this demand at present is may be realized when it is considered that if a tree were growing at each end of every railroad tie laid in the track in the whole United States all the timber produced would be needed for renewal alone. In other words, two trees must always be growing in the forest to keep one tie permanently in the track.

By its studies of lumbering methods the Forest Service has shown lumbermen how timber formerly wasted in high stumps, tops, and logs left in the woods could be utilized without added expense. And a not less serious waste of a great resource was cut off when the invention of a new method of turpentining made it possible to eliminate the destruction of our southern forests through boxing the trees, and at the same time to gather a far larger value in turpentine than before.

FOREST EXPLORATION.

Finally, the Forest Service has rendered a great service by its explorations of forested regions. Useful contributions to the knowledge of our forest resources have been made through specific studies of important regions. The guiding principle of this policy is, of course, that all land should be put to its best use. This principle the Forest Service has assisted to put into effect by its recommendations as to what lands should not as well as what should be reserved.

RESERVE ADMINISTRATION BY THE FOREST SERVICE.

The Forest Service had become fully qualified, by its past work, for the responsibility laid upon it by the transfer of the reserves to its administrative charge. The immediate effect of the change was the opening of the reserves to much wider use than ever before. This is the natural consequence of intrusting the care of these great forests to the only branch of the Government which has the necessary technical knowledge. The inevitable consequence of a lack of such knowledge must be the restriction of right use or the practical certainty of

misuse. Only under expert control can any property yield its best return to the owner, who in this case is the people of the United States.

Under the system of administration now in force everything affecting the reserves is determined or executed by men of expert knowledge, familiar with local conditions. This entire force has become a part of the classified civil service. Timber is cut only under the supervision of trained men in accordance with a plan carefully prepared to safeguard the permanent welfare of the forest; yet the sales of timber have many times increased since the Forest Service took charge. A far more complete control is exercised than formerly, yet the net cost to the Government of all the work of the Service will be less for the present year than that of the Bureau of Forestry alone before the transfer. A property worth in cash not less than $250,000,000 is administered at a cost of less than one-third of 1 per cent of its value, while increase in that value of not less than 10 per cent per annum is taking place. As the use of the reserves increases the cost of administration must, of course, increase also, but receipts will certainly increase much more rapidly. The forest reserves are certain to become not only self-supporting but a source of large public revenue.

Work of the Year.

The transfer of the National forest reserves to the care of the Department of Agriculture was effected on February 1, 1905. The administration of these vast forests fell quietly into its place in the Service, and has since been conducted with steadily advancing efficiency. Every office in the Forest Service is actively concerned in their management, working and planting plans are in preparation and have been prepared for various parts of them, and they are absorbing and will continue to absorb a greater and greater part of the work of the Forest Service.

FOREST MANAGEMENT.

PUBLIC LANDS.

On the public lands greater strides were made in the introduction of forest management than ever before. Wherever on the reserves timber is in present demand working plans are being prepared which will insure the best use of the forests. On the Chippewa Indian Reservation, in Minnesota, the complete success of the plan to secure the perpetuation of the forests is assured. In California, Colorado, Montana, South Dakota, and Wyoming studies of leading commercial trees have provided a basis for the intelligent management of the forests in which these trees hold an important place, including many of the reserve forests.

PRIVATE LANDS.

The movement to introduce forest management on private lands is spreading rapidly, especially in the Pacific Coast States and the Middle West. Nearly four-fifths of the applicants for cooperative assistance were small owners. The total area for which assistance was

asked was nearly 1,500,000 acres. Examinations to determine the practicability of management were made of 22 large timber tracts in 15 States, and detailed working plans were made for 8 large and 81 small tracts, with a total area of almost 2,000,000 acres.

FOREST EXTENSION.

Up to the present year the work in extension found altogether its largest field of usefulness in the preparation of planting plans for farm protection and local timber supply in the scantily timbered regions of the Middle West. It is certain that tree planting will always hold an important place in farm economy, but it is more and more becoming possible to supply the needed information for this work from the central office as a result of regional studies. The large projects involved in the establishing or replacing of forests on reserve lands now unforested, and in demonstrating to the consumers of timber that they must provide for their future needs, will probably for the next few years increasingly claim the attention of the Forest Service.

During the year a revision of the terms of cooperative assistance was made to induce wider acceptance by small owners. Up to the present time 380 planting plans have been made, of which 49 were made during the past year.

Reserve planting during the year included the establishment of nurseries in the Santa Barbara and Gila River reserves, broadcast sowing and field planting on the Black Hills Reserve, and field planting in the San Gabriel and Dismal River reserves, besides the extension of previously established nurseries. The experiment in broadcast sowing in the Black Hills is especially notable, because the results obtained now appear to be entirely favorable and because success has never before been gained under this method in this country. The significance of this fact lies in the enormous difference in the cost of reforesting by sowing seed on ground not previously prepared and of rearing and transplanting nursery stock for large areas.

By the completion of the cooperative study conducted in the State of California valuable information was secured concerning the relation of chaparral to water conservation and forest renewal and concerning fire protection.

FOREST PRODUCTS.

Lines of cooperative work now completed have brought definite and important results in introducing preservative treatment as a means of increasing the durability of ties, and thereby decreasing the drain upon the forests. The results give good reason for the belief that tie preservation will shortly become practically universal.

The study of the preservation of telegraph and telephone poles promises further economies of the same kind.

In timber tests, studies of red gum, red fir, western hemlock, and loblolly and longleaf pine have furnished facts which will lead to the wiser use of these species and of structural timber generally. Strength tests of woods for other purposes have been begun, and methods have been prepared for the more extensive prosecution of

this very practical work; but the full utilization of the opportunity presented for public usefulness must wait until the necessary facilities are provided.

DENDROLOGY AND FOREST EXHIBITS.

Progress was made during the year in the general study of forest distribution, classification, and composition throughout the United States, especially through regional studies. Previous studies of basket willows and turpentining methods have been continued with further helpful results.

BUREAU OF CHEMISTRY.

During the period begun July 1, 1897, and ended June 30, 1905, the present Bureau of Chemistry has increased its activities, and by reason of its enlarged work was raised from a division to the rank of a bureau July 1, 1901. The work of the Bureau has been seriously retarded, both during the past eight years and prior thereto, by reason of the large number of employees who, having attained a reputation for efficiency and ability, have been induced by superior opportunities of advancement to resign from the Bureau and enter work for other institutions or corporations. Nineteen of the promising members of the Bureau, during these periods, have resigned to enter more lucrative employment in other positions.

CEREAL INVESTIGATIONS.

The chemical investigation of the cereal products of the United States has been one of the principal items of work, and several bulletins have been published embodying the results of the investigations. Starting from the mean composition of the principal cereals, the chemical studies of the products made therefrom have included flours, meals, breads of every description, breakfast foods, cakes, and biscuits.

The changes which take place in cereal products during the process of milling are fully discussed in the above publications.

PREPARED MEATS.

Important investigations, also, were made in the study of prepared meats. As a result of these investigations it was shown that the process of parboiling, or "shrinking," as it is technically called, is practiced to produce a marketable article, since meat must be cooked before it is canned. The process was shown to detract little from the muscle-forming elements of the meat. The only substances removed in any considerable quantity are fat, soluble ash, and meat bases. In addition to this work, a systematic examination of the canned goods sold in the American markets was undertaken, and a total of 513 samples of such products were examined. It is interesting to note in connection with this work that in addition to the above 39 samples of horse meat were obtained, designed, according to statements made, for export to foreign countries.

The investigation of canned meats has proved of particular advantage, both to the manufacturers and consumers. That meat can be

preserved unharmed for a long time when thoroughly sterilized in cans has been fully established as the result of the investigations. It has further been shown that it is not necessary in preserving the meat in this condition to add any chemical preservative whatever. The meats thus prepared preserve their wholesome properties and nutritive value and do not lose appreciably in palatability when not kept for too long a time.

FOOD PRESERVATIVES.

Elaborate studies have been made of the character of preservatives used in food products and the best methods of detecting them. These investigations have proved most useful to all workers in this line in the United States and foreign countries.

An important investigation has also been made to determine the effect of preservatives and coloring matters, when added to foods, upon the health of the consumer. To this end a class of young men was secured to whom were fed foods containing these articles. In so far as the investigations have been completed, it has been found without exception that the addition of the ordinary preservatives to foods is prejudicial to health. The same is true, also, of at least one of the coloring matters commonly employed, namely, sulphate of copper.

The results of these investigations show the need of protecting the public by legislation against the addition of such articles to foods, either by prohibiting their use altogether or by regulating the amount thereof and securing a statement of composition upon the label of each package.

FOOD STANDARDS.

Important investigations have been conducted by the Bureau of Chemistry looking to the establishment of standards of purity for foods. The results of these investigations have been laid before the food standards committee of the Association of Official Agricultural Chemists, a body authorized by law to advise the Secretary of Agriculture, which has been instrumental in forming the standards already published as well as those which are still under consideration.

The lack of uniformity in the food legislation in the various States is a source of great annoyance to manufacturers and dealers. The Bureau of Chemistry has cordially cooperated with the officials of the various States in their efforts to regulate the manufacture and sale of adulterated foods, drinks, and drugs. It is becoming more and more evident, however, that for the complete control of evils of this kind interstate regulation of commerce in such articles is necessary.

THE INSPECTION OF FOODS INTENDED FOR EXPORT.

The Congress of the United States has authorized the Department of Agriculture, through the Bureau of Chemistry, to inspect all food products intended for export to countries whose laws require a physical or chemical inspection of foods. This privilege, however, is optional with the exporter. He is not compelled to secure such an inspection, but is authorized to do so if he so desires. Under this law a great many of the exporters of food products in this country have applied to the Department for inspection of their goods. They have

thus been enabled to send with the foods to foreign countries a certificate of inspection, which as a rule is accepted as prima facie evidence of purity. It is evident that our foreign commerce in food products would be greatly promoted if this practice should become general, and our foods would thus acquire a standing in foreign countries which would remove from them all suspicion of impurity.

INSPECTION OF IMPORTED FOODS.

Congress has also authorized this Department to inspect all food products offered for entry into the United States from foreign countries and to refuse delivery to the consignee of all products which are found to contain any added substance injurious to health, or to be misbranded in any particular, either as to their contents or origin, and of such products as are forbidden or restricted in sale in the country from which they come or from which they are exported. In order to carry this law into effect, branch laboratories of the Bureau of Chemistry have been established in the ports of New York, Boston, Philadelphia, New Orleans, San Francisco, and Chicago.

As far as the facilities at hand will permit, all food products entering this country are inspected and analyzed before delivery to the consignee. As a result of this inspection a great improvement in the character of our imported foods has already been secured. There has been developed also among the exporters from foreign countries a desire to send only such articles as may conform to the requirements of the laws of the United States.

During the period between July 1, 1903, when the enforcement of the law began, and June 30, 1905, 3,576 invoices of food products were inspected, among which 712 were found to be of a character forbidden by law.

TABLE SIRUPS.

Important investigations have been made in the last few years looking to the improvement of the character of the table sirups so largely used in the United States. These sirups are made chiefly from the maple tree, from sorghum, and from sugar cane. These investigations have shown the best methods of procedure in all these cases to secure a product of the highest quality, free from added chemicals. Several bulletins have been published embodying the results of these investigations.

INSECTICIDES.

An elaborate study has been made of the insecticides in use in the United States, in collaboration with the Bureau of Entomology. These investigations have shown that many of the insecticides offered to our farmers are of little value, and that the price demanded and the value of the goods are not always proportionate. These studies have tended to protect the farmers of the country and secure for them a much better quality of insecticide for the money expended.

CONTRACTS.

In the Contracts Laboratory studies are made of the materials submitted for the Department of Agriculture, and other Departments

of the Government which may ask for such studies. The results of these studies are of the greatest practical benefit in securing for the use of the United States Government materials which fully conform to the requirements of the contract and the character of the samples submitted. The extension of this inspection to all materials supplied the United States Government would undoubtedly prove advantageous.

DRUGS AND CHEMICALS.

The importance of pure drugs from the hygienic and remedial standpoint is evident to everyone. Congress has authorized the study by the Bureau of Chemistry of the purity of drugs, their nature, and the sophistications to which they are subject. The Drug Laboratory of the Bureau of Chemistry pursues investigations of this kind, as well as of the purity of chemicals and reagents offered for the use of the Bureau.

COOPERATIVE WORK WITH THE ASSOCIATION OF OFFICIAL AGRICULTURAL CHEMISTS.

The work of the Bureau of Chemistry in connection with the Association of Official Agricultural Chemists of the United States has been of a most useful character. This association is composed of all chemists connected with agricultural colleges, experiment stations, State and municipal boards of health, boards of agriculture, etc.; hence it represents some of the most important activities in connection with agriculture. By act of Congress this association is made the adviser in certain respects of the Department of Agriculture, and this Department has extended its patronage to the association from the beginning, with great mutual benefit, and still greater benefit to the agricultural interests of the country.

CIDER AND WINE INVESTIGATIONS.

It is well understood that the character of ciders, wines, etc., is due to the chemical reactions which take place during the process of fermentation. Special studies have been made by the Bureau of Chemistry of these chemical reactions, especially with relation to cider, and numerous cultures of yeast, producing specific properties, have been made and distributed.

Careful studies of the wines of this and other countries have also been made which have proved of great practical benefit.

COLLABORATION WITH OTHER DEPARTMENTS.

Under the authority of Congress the Bureau of Chemistry is authorized to collaborate with other Departments which may require its aid. Under this authority work is constantly done for nearly all the Departments of the Government. A large number of investigations has been made for the Treasury Department; also for the War Department, especially for the Commissary-General; for the Interior Department; for the Navy Department; for the Department of Commerce and Labor, and for the Department of Justice.

During the last two or three years the most important of the collaborative work with the Departments is that which has been done in

connection with the Post-Office Department. The Postmaster-General submits constantly to the Department of Agriculture for investigation samples of various substances which are intended either to be sent through the mails or advertised in newspapers, magazines, and circulars sent through the mails. Under the law poisonous matters and those which are combustible in character or dangerous to other wares are not allowed to be sent through the mails. Samples of such suspicious bodies are constantly submitted for investigation.

There are continually appearing advertisements of remedies said to possess most remarkable characteristics and to effect marvelous cures. Where such advertisements appear to be fraudulent in character, they are submitted, together with samples of the remedies, to the Bureau of Chemistry. After careful examination of the samples and of the literature reports are made to the Postmaster-General, embodying the results of our investigations and the conclusions based upon them. On these investigations and conclusions the Post-Office Department bases its action in either continuing the use of the mails for the distribution of such advertisements or debarring them from the mails as fraudulent. Much benefit must necessarily come to the people of the country from work of this kind.

BUREAU OF SOILS.

The work of the Bureau of Soils is of such a fundamental character that its results are being more and more widely used, not only by the other Bureaus and Divisions of the Departmental work, but by State agricultural experiment stations and State geological and economic surveys, as a foundation for further work along highly specialized lines. At the same time that the demands upon the Bureau for additional work are increasing, the facilities for accomplishing this work have remained stationary or, in one case, been decreased.

During the past eighteen months the Soil Survey has lost by transfer to the United States Geological Survey, by assignment to alkali reclamation work within the Bureau of Soils, by the cooperation with other Departments of the United States Government and of the Philippine government, by special detail to educational institutions, and by resignations twenty of its most highly trained and efficient assistants. The Survey force, even with these depletions, mapped over 28,000 square miles during the calendar year 1904. With twenty parties of two men each continuously engaged in field mapping, about 35,000 square miles per annum could be surveyed and mapped.

The Bureau of Soils has on file at the present time requests for the mapping of two hundred and fifteen counties, located in forty States and Territories, and aggregating upward of 150,000 square miles. These requests are supported by 265 organizations and individuals.

Requests are on file either from the directors of experiment stations or from the State geological survey organizations for surveys of all of the areas of several States.

The Soil Survey at the present time is equipped with a force of 29 field men and some of the necessary executive and special assistants. In order that the work of this survey may be kept at its former

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efficiency, in view of the recent depletions, it becomes necessary to increase the number of field men engaged upon actual survey work to 40 persons, thus allowing the maintenance of 20 parties upon continuous field work. On account of the necessity of providing for resignations, for annual leave of absence, and for necessary sick leave, additional men are needed to keep these field parties constantly at their full efficiency. For this maintenance of the field force at least 12 more men are required for the Soil Survey service. To keep in close touch with all of the work as it is being conducted in the field and in order that the necessary correlations of the soils of one area with those of other areas which are in progress of mapping or have already been mapped may be made, it is necessary to have two inspectors, both highly trained men, appointed from the present Survey force, who will visit each area during the progress of the work and advise the men in regard to all difficulties which can not be solved through correspondence. Through their personal contact with the men the inspectors will keep the field work up to the highest state of efficiency and economy. The places on the Survey thus made vacant would need to be filled by the appointment of two new men at smaller salaries.

The character of the work already accomplished and the broad scope of the problems encountered in the areas already surveyed are shown by a recapitulation of the work of the Soil Survey from its inception to June 30, 1905. All of the problems encountered in the field require additional research work in the laboratory for their complete solution. This is particularly true of the two great problems of American agriculture which concern, respectively, the arid lands and the humid lands of the United States. The first study concerns the accumulation of soluble salts, known as alkali; the second problem is that of soil fertility, or, as it is sometimes stated, that of "worn-out soils." Both of these problems are being studied by the laboratory force, and the results obtained are published in the form of special bulletins, which summarize the scientific facts discovered, and also in the form of circulars or additions to the Soil Survey reports, in order that the results may be placed in such a form as to constitute a practical working basis for the persons whose farms are concerned. In the same way the Tobacco Investigation work follows and supplements the Soil Survey. Recently arrangements have been made whereby cooperation has been secured with certain agricultural experiment stations and with the Office of Farm Management of the Department of Agriculture. Through this arrangement it is hoped to come into very close touch with all branches of American agricultural activity.

EARLY WORK OF THE SOIL SURVEY.

The first work of the Soil Survey consisted of preliminary studies of the tobacco soils of the United States and of the alkali soils of the Yellowstone Valley. These investigations showed that a field map could be constructed which would represent graphically the classification, occurrence, and distribution of distinctive types of soils. It was also found that in the arid regions of the West a second map should be constructed which would show the amount and character of the alkali, which frequently interferes with crop production or

totally prohibits it. It was also found in the case of the arid regions that a map showing the depth to permanently saturated soil was necessary. For this reason, in the conduct of soil surveys in the arid regions, a soil map, an alkali map, and a ground-water map are prepared, whereas in the humid regions the soil map alone is sufficient. Each of these survey maps is accompanied by a report upon the climatic surroundings of the region, its transportation and market facilities, and the special adaptation of different crops to the different soil types, together with an outline of the transportation problems and of such other commercial, economic, and other essential facts as directly influence agricultural welfare and agricultural life.

THE VALUE OF THE SOIL.

The soils of the United States are considered as the greatest natural economic endowment of the American people, far exceeding in the value of their annual products all of the returns secured from mines and fisheries. It is the purpose of the Soil Survey work to outline the most economical method of securing the utmost efficiency in the handling of these soils and in the production of food products from them. The questions involved concern not only the farmers themselves, but also every person interested in labor, commerce, manufacturing, or professional life. The problems are fundamental.

The studies thus far made of the soils of the United States include the survey of 197 separate areas, located in 44 States and Territories. These surveys aggregate 63,621,120 acres, or 99,408 square miles. They have been so distributed as to constitute a study of soil conditions in all the different physical divisions of the United States and for all of the chief staple crops. In addition, the special conditions favoring the production of special crops under intensive methods of agriculture have also been studied.

Surveys of the tobacco soils of the United States have been made in 16 different States. Their results show that the variety of leaf produced is controlled largely by the texture of the soil upon which the crop is raised. Thus, the heavy clay soils produce a thick, gummy leaf, while the lighter sands produce wrapper leaf and bright tobacco.

The soils of the truck-producing regions along the Atlantic and Gulf coasts have been studied from Rhode Island to Texas. It has been found that the Norfolk sand is the best soil for the production of early truck crops in all of the tide-water districts of the eastern coast line. Where market facilities and transportation are favorable the land values upon the Norfolk sand have risen from $5 or $10 per acre under general farming conditions to $100 or $200 per acre for the production of sweet potatoes, early Irish potatoes, melons, small fruits, and small vegetables. The interior truck regions of the Central States have been similarly studied, and in this region the Miami sand has been found to be the type of soil best adapted to truck farming.

The grape soils of the United States have been studied in the Lake Erie region and in California. It has been found that the sandy and gravelly soils adapted to the production of the eastern wine and grape-juice grapes do not furnish a product well suited for shipping, and the production of table grapes for distant markets is best accom-

plished upon the heavy clay and shale-loam soils of what is known as the Dunkirk series. In the California grape belt of the San Joaquin Valley the alkali problem was found to be serious. The soil-survey work around Fresno has been followed by alkali reclamation work. It has been shown that with an expenditure of less than $40 per acre soils which have decreased to the value of $20 or $30 per acre for grass and grain production can be restored to their former value of $350 to $700 per acre for grape production.

STUDY OF APPLE SOILS.

The apple industry has been served in two notable instances. The soil survey of the Lyons area in Wayne County, N. Y., was followed by an orchard survey made under the direction of the horticultural department of Cornell University. Thus, a map showing the adaptation of apples to the various soils has been supplemented by a comprehensive bulletin which discusses the question of the varieties to be raised for commercial marketing, the methods of culture and the fertilizer to be employed, questions of storage and shipment, and even the facilities offered by the different domestic and foreign markets. In the same way the great pippin belt of Maryland, Virginia, and North Carolina has been studied. It was found that the profitable production of pippins was confined to a single soil type—the Porters black loam—occurring in the coves and small valleys of the eastern ranges of the Allegheny Mountains. It was also found that not only were the most successful orchards located upon this soil type, but also that a distinct climatic belt also existed within which the pippin production was especially favored. On account of differences in latitude this belt descends from higher elevations in the South to lower elevations northward. In Virginia it occurs between altitudes of 1,200 and 3,000 feet.

SOILS ADAPTED TO CITRUS FRUITS.

On the Pacific coast extensive studies have been made of the soils adapted to citrus fruits. Here it has been found that not only the soil played an important part in the location of groves of citrus fruits, but that the alkali problem and the conservation of irrigation water constituted dominating factors. The use of irrigation water containing considerable amounts of soluble salts for the safe irrigation of citrus and pomaceous fruits has been studied in this district. The melon-producing areas around Rockyford, Colo., and Indio, Cal., have been studied and the soils best adapted to the production of high-grade cantaloupes determined. It is found that the fine sandy loams of both regions, under proper irrigation conditions, constitute the best melon soils.

SUGAR-BEET SOILS.

In conjunction with the extension of the sugar-beet industry into eastern areas, it has been found necessary to take up the study not only of eastern sugar-beet soils, but the study of the soils upon which sugar beets have long been produced to advantage in the irrigated districts. It has been found that the soils best adapted to raising sugar beets in the arid regions are not at all the soils adapted to sugar-beet produc-

tion under humid conditions. In the former the sandy loams and adobe soils constitute the main sugar-beet producing types. In Wisconsin, Michigan, northern Ohio, and central New York the heavier loams or clay loams well supplied with moisture and still not too stiff to interfere with root development constitute the best soils for this crop. In Michigan and northern Ohio these soils are the Clyde loam, Clyde sandy loam, and Miami black clay loam. All of these are dark in color and contain considerable quantities of partially decayed organic matter. In New York the Miami stony loam and Miami silt loam are the soils upon which the best results are obtained.

ALFALFA SOILS.

The introduction of alfalfa into the Eastern States and its production under humid conditions have necessitated a study of alfalfa soils from New York to Alabama and Texas, and also throughout the central prairie region. While the soil factor is not the only one controlling the introduction of this crop, it has been shown that when other conditions are reasonably favorable the Miami stony loam of the Northeastern States almost invariably gives the best results for alfalfa growing. Similarly, in the Gulf Coast States, when proper drainage can be secured, the Houston black clay or the black "waxy land" of the Cretaceous prairies, as it is locally known, constitutes a soil type upon which alfalfa grows almost spontaneously.

RICE AND SUGAR CANE SOILS.

The rapid development of the rice industry in Louisiana and Texas within the last decade has necessitated a study of the soils of that general region. It has been shown that under the modern conditions of production, with the use of heavy power machinery and under copious irrigation, the heavier silt loams and clay loams of the low-lying Louisiana and Texas prairies are best adapted to this modern industry. The Crowley silt loam, Lake Charles fine sandy loam, and other similar types are the ones upon which this crop is meeting with the greatest success.

The sugar-cane interests have been served by a number of surveys along the Gulf coast. One area of special interest was mapped around the sugar station of the Louisiana Experiment Station. The results obtained upon the soils mapped in this area can readily be applied in connection with the same soil types mapped in the other Gulf coast areas.

While the Soil Survey is thus serving numerous special interests and in a great many instances obtaining new results which are striking and gratifying, the total value of these is possibly small compared with that which comes from a study of the soils which produce our great staple crops like grass, wheat, corn, oats, and cotton.

IDEAL CORN SOILS.

The study of soil conditions in the great central cereal belt of the United States has demonstrated that three types—the Marshall silt loam, Marshall loam, and the Miami black clay loam—are beyond

dispute the ideal corn soils of the central prairie States. The study of the extent and distribution of these three types, whose products dominate one great branch of American agriculture, has led to a better understanding of the conditions which lead to successful corn production. As the studies of corn breeders have led to new inspiration in the plant side of corn production, so the delimitation of these types of soil so admirably adapted to the production of maize will furnish direction for increased specialization in the selection of the best possible soil conditions for corn production.

At the same time it has been shown by the soil surveys that the typical corn soils of the central prairie States are not at all the most desirable corn soils for the northeastern and eastern tide-water States. Owing to greater elevation and a consequent shorter season the corn crop can be matured only upon those soils which are at once well drained, well warmed, and sufficiently retentive of moisture to satisfy the demands of a heavy, rank-growing crop. So in New York and the northeastern States in general the gravelly and stony loams lying below an altitude of 1,500 feet constitute the corn soils.

Again, in the Piedmont and Coastal Plain regions of the southern seaboard States it has been found that another entirely different set of conditions must be met. Corn does not thrive below an altitude of 100 feet, just as it is not successfully cultivated above 1,500 feet. Again, certain climatic peculiarities intervene to alter conditions of production. As a result the heavy loams and clays of the Cecil and Penn series and the heavier loams of the Orangeburg and Norfolk series constitute the soils best adapted to corn culture in these regions.

In addition to these uplands suited to corn production in the Southern States the narrow alluvial bottom lands, frequently subject to overflow, are found to constitute by all means the best corn soils of the region, and only their limited extent and the difficulty of protecting them from destructive inundation prevent these soils from being recognized as among the most desirable of any in the United States for corn production. The problem of the proper protection of these bottom lands, either by watershed forestation or by local levees, constitutes one of the most important problems of local production of provision crops throughout the South.

SOILS ADAPTED TO SPECIAL CROPS.

Several soils of the Northeastern States upon which an unsuccessful attempt is being made at the present time to produce cereal crops actually constitute the best grass lands of the region. This is particularly the case of the Volusia silt loam of northeastern Ohio, northern Pennsylvania, and southern New York. This soil lies at an altitude of 1,300 to 2,000 feet above sea level, and the production of corn is an uncertainty on account of the occurrence of unseasonable frosts. As a result, the farming population of this general district, particularly in the hill lands, is becoming discouraged and disheartened, while the soil with which they are dealing is admirably adapted to the production of grasses, oats, and buckwheat. The abandonment of grain farming and the turning to dairy industry and stock raising, based upon hay and oat production, would seem to be highly desirable throughout this general region.

STUDY OF COTTON SOILS.

A constant study is being made of the cotton soils of the Southern States. These communities have shown wonderful progress both in agriculture and manufacturing during the past decade. The study of soils in the Yazoo and Red River basins of Mississippi and Louisiana has shown ideal soil and climatic conditions for the continued production of maximum cotton crops. The annual overflows naturally enrich the plantations and render the soils subject to this influence of almost inexhaustible fertility. It was pointed out in the Yazoo report that the chief problem of these regions was to secure adequate protection from destructive inundation, while still securing the fertilizing benefits of the overflow waters.

Similarly the Upland cotton regions have been found to present two dominant soil problems. The first is that of preventing the bodily removal of the fertile surface soil through erosion; the second is that of securing such a rotation of crops and use of green manures as will restore the organic matter to soils depleted by long-continued clean cultivation in one crop. Both of these problems can be met and are being met by enterprising farmers in nearly every community where soil surveys have been made. The mere statement of these problems and the accounts given of cases where their solution has been worked out are of inestimable value to the planters whose attention has not formerly been called to the work already done by their own neighbors and by their local authorities.

ARID AND SEMIARID REGIONS.

The introduction of durum wheat into the regions sometimes deficient in rainfall, but not naturally arid, requires a careful investigation of the soils to which this new crop is best adapted. So soon as the proper soil conditions can be ascertained there is a good prospect that a vast region marked formerly by uncertain harvests can become dependent on a totally new industry adapted to its peculiarities of soils and climate.

The interests of agricultural areas as yet undeveloped have also been served. The new irrigation areas of the arid States are being investigated and maps made which show not only the kinds of soils which exist and their proper crop adaptation, but also the locations of land too alkaline to be of any present value for crop production.

PRACTICAL UTILIZATION OF THE SOIL SURVEYS.

Survey of single areas of this description have furnished prospective settlers with information which has prevented the unwise investment or total loss of thousands of dollars, in many instances constituting every dollar possessed by the individual. At the same time these settlers have been directed to lands within the same areas where their investments could be made with safety and their new homes established without risk of disappointment. The actual settler has thus been benefited, and new communities have secured advance information which only years of bitter experience would have furnished them under their own undirected efforts.

It will thus be seen that the Soil Survey reports and maps concern not only those engaged in the broad study of economic agriculture and its resources in the United States, but that they are of high value for daily use by a great variety of agricultural and commercial interests. The increase of the use thus made of the maps and reports is evidenced both by the requests received for reports already published and by the requests which are continually being made for additional surveys. It is possible only to enumerate the interests which make these requests. These include canning companies, granges, farmers' clubs, and other agricultural organizations; the leading educational institutions, not only those practically interested in agriculture, but also those which study agriculture as a portion of the economic system of the United States; the geological departments of the leading universities, and botanical, geological, agricultural, forestry, and irrigation surveys. The use of these maps by individual farmers, and particularly home seekers and those desiring to engage in special intensive forms of agriculture, is rapidly increasing. This is shown by the fact that maps of areas which are being developed along new lines of fruit growing, trucking, or market gardening are in great demand by individuals. Thus, Long Island, N. Y., Wayne County, N. Y., Norfolk, Va., and other areas mapped in the older settled States have met with the largest demand for single copies of the report and map of any of the areas published during the last two years.

MAINTENANCE AND RESTORATION OF SOIL FERTILITY.

The study of the main agricultural question of the humid sections—that of maintaining soil fertility, or of restoring lands to their former crop-producing power—has been taken up. It has been found through centuries of experience that there are three chief methods for maintaining the fertility of soils. The first of these—manuring or fertilization—is most generally practiced in the United States; the second method—crop rotation—is also widely practiced, and its importance is becoming thoroughly understood; the third method—that of proper culture or tillage, which would include drainage and irrigation—is of more modern origin, so far as the American people are concerned, and is less thoroughly understood and less widely practiced. A study of the relative values of each of these methods and of the relationship of each to the other must be made in order to meet the requirements of recent growths of agriculture in the United States. The broad areas of virgin soil which formerly existed in the United States invited the most superficial cultivation. Crop rotation was neglected or carried on in a haphazard fashion. Under mismanagement and unwise methods, engendered by long periods of abundant cheap land, the time must sooner or later arrive when the soils do not respond to cultivation with profitable crops. Recourse is then had to some form of fertilizer. This point has already been reached in certain portions of the United States.

NEW METHODS FOR TESTING FERTILIZER REQUIREMENTS.

In order that the restoration of these lands through the application of different manurial and fertilizer compounds may be accomplished most economically, the problems of soil fertility and of soil manage-

ment have been taken up by the Bureau of Soils. New methods have been devised for testing the fertilizer requirements on each of the principal soil types encountered by the Soil Survey. This method gives results in about six weeks' time which have been found to be practically comparable with the results of plot experiments carried on over longer periods. The new method has been tested against the fertilizer and manurial plots of two leading experiment stations, one in Rhode Island and one in Ohio. The results of these tests have been highly satisfactory, not only to the Bureau of Soils, but also to the directors of the two stations. Letters from them are on file which show their appreciation of this new line of work. In order that the method may be completely tested, work has been arranged for the ensuing year in cooperation with four additional stations.

The parties assigned to this work will study not only the manurial requirements of soils occurring at the stations, but they will also study the fundamental questions of the principles involved in the maintenance of soil fertility. In addition to this use of the new methods devised in the Bureau laboratories, work is being carried on for the determination of the manurial requirements of each of the principal soil types of the United States as they are encountered in the different areas which are being surveyed. The soils from thirty-nine different localities have already been investigated and a circular giving the results of these investigations has been published in three of these cases. It will thus be possible in connection with each survey to include directions for the fertilization of each of the different soil types encountered, with the reports upon the areas as they are published. It is only natural that investigations into such fundamental problems as those concerning soil fertility and manurial requirements should attract general attention and bring numerous comments from other investigators along the same lines. This has been more pronounced in the fertility studies, because not only the results obtained, but also the viewpoint and even the methods employed, were essentially new. It has been found necessary, in addition to the publication of the usual bulletins and circulars, to meet many of these inquiries by lectures upon the principles of the work and by exposition of its method of operation before the faculties and students of several scientific institutions. As these methods are becoming more thoroughly understood they are being gradually adapted for scientific work along the same lines by investigators who are working outside of the Department of Agriculture.

RECLAMATION OF ALKALI LANDS.

Another of the important problems of American agriculture—that of the control of alkali—chiefly concerns the arid regions of the United States. As a result of the very first survey work in such areas, it became manifest that certain methods should be employed to prevent the accumulation of alkali in irrigated lands and to reclaim those lands which had already been damaged by accumulations of soluble salts. This situation was met in earlier reports by recommendations concerning proper methods to be employed, but it was found that in order to bring this matter convincingly before the people most concerned and to get them to follow the recommendations made, it would be necessary to conduct actual demonstrations; consequently

in 1902 the work of the Alkali Reclamation Service was begun upon the Swan tract, near Salt Lake City, Utah. This tract has been thoroughly underdrained, and frequent applications of irrigation water have been made by the method of flooding. After three years this land, which at the inception of the demonstration produced only greasewood and saltbushes, has produced fair crops of wheat and alfalfa. At the expiration of another year this tract should be completely reclaimed, and in addition should produce good yields of farm crops adapted to the soil and climate.

Similar demonstrations have been undertaken in Montana, Washington, California, and at an additional station in Utah. These demonstrations will be completed in about the same time required for the original Swan tract. This reclamation of alkali land by thorough underdrainage, on account of the expense involved, is adapted only to the reclamation of lands of relatively high value.

TEXAS TOBACCO SOILS.

In Texas the possibilities of certain soils of the Orangeburg series for the production of high-grade filler tobacco have been investigated by field parties with headquarters at Palestine, Anderson County, and with substations in Nacogdoches County and Houston County. Experimental fields aggregating 103 acres have been planted in cooperation with thirty-four different farmers. The entire production of the Texas fields has already been bought by a Chicago firm at a very satisfactory price, and it was bought before the crop was even fermented. It is thus evident that a ready market for the Texas product can be secured.

The people of this general region are totally unskilled in the technical details of the production, curing, and marketing of tobacco. At the same time, the invasion of the boll weevil has rendered the introduction of some crop in addition to cotton highly essential to the welfare of this agricultural community. It is therefore necessary for the Department to maintain these tobacco stations in this region long enough to encourage and advise the individual farmers in firmly establishing this new line of crop production. A great interest is taken in this tobacco work by individuals and business organizations in eastern Texas. The same line of work has been taken up in Alabama, around Marion, with the same general results.

TOBACCO WORK IN OHIO.

In Ohio the Bureau has practically finished its experimental work. The crop grown upon 32 acres in cooperation with eight different farmers in Montgomery County was purchased at very remunerative prices even before it was cut. The work of tobacco fermentation in cooperation with the Ohio tobacco men has been continued. This is the fourth season for this line of work, and practically all of the Ohio packers have now abandoned the old practice of case fermentation, substituting the Bureau method of bulk fermentation. This change has resulted not only in the saving of thousands of dollars formerly lost through imperfect curing and through black rot, but it has also added materially to the profits of all tobacco by a general improvement in the quality of the different crops.

TOBACCO WORK IN VIRGINIA.

Work has been extended in the dark-tobacco districts of Virginia, where tobacco growers were securing very unsatisfactory returns for their labor. A station was established in Appomattox County and a number of experimental plots established upon the Cecil clay. Different methods of fertilization and of handling were tested. The result of a single season's work indicates that the methods introduced by the Bureau of Soils will result in profits on the investment of fertilizer and labor of from 13 to 35½ per cent. These conclusions are drawn from the results of actual field experience. Although only one year's work is concerned it has been clearly shown that by a judicious use of fertilizers and with thorough and proper cultivation it will be possible for the Virginia tobacco raiser to increase his yield and his profits materially.

SHADE-GROWN TOBACCO IN CONNECTICUT.

The work in the Connecticut Valley upon shade-grown wrapper leaf has been continued. The object of this work is to develop a type of tobacco which at the same time is adapted to the soil and climatic conditions of Connecticut and to the market demands. During the year nearly 100 bales of this tobacco have been sold for domestic use. The prices obtained range from 20 cents per pound to $1.75 per pound, with an average of 75½ cents. Eighty-six bales unsuited to the domestic demands were sold for export at prices ranging from 10 to 70 cents per pound, with an average price of 27.8 cents per pound.

MISCELLANEOUS TOBACCO WORK.

The tobacco work of the Bureau of Soils includes the improvement of domestic filler tobacco through the introduction of the Cuban seed-leaf industry into the Southern States and into Ohio; the introduction and supervision of the bulk fermentation process in Ohio; the completion of the experiment for producing a shade-grown wrapper tobacco in Connecticut which will meet trade requirements; improving the fire-cured types of shipping tobacco in Virginia; and it is very desirable that investigations of the same kind should be made in the tobacco districts of New York, Pennsylvania, Maryland, Wisconsin, Kentucky, and Tennessee.

Requests for this work have been received from many farmers, from various tobacco growers' associations, and from a variety of trade interests. The importance of this work is obvious, and the Bureau is prepared to carry on and enlarge this line of work in the future as rapidly as appropriations can be made available.

BUREAU OF ENTOMOLOGY.

The work of the Bureau of Entomology during recent years has greatly increased, and beneficial results have been obtained in many lines of work, while several new and important branches of investigation have been entered upon.

THE MEXICAN COTTON BOLL WEEVIL.

The large-scale experimental work made possible by the emergency appropriation of Congress was carried on to the close of the season of 1904, and was taken up again in the spring of 1905. The territory infested by the boll weevil had unfortunately considerably increased both northward and eastward by the close of the season of 1904, at which time it covered approximately 98,000 square miles in Texas and Louisiana.

EXPERIMENTAL FARMS.

The territory in question probably exhibits as great variation in rainfall, temperature, and other particulars as any area of like size in the United States. Therefore it was necessary to establish fourteen experimental farms, where all sorts of experimental work were carried on. The adaptability of the weevil to new conditions, as has been shown by its having acquired an ability to become perfectly acclimated in the United States, is also witnessed in local variations due to climatic and other conditions. The general cultural method was tested in these various localities, as well as the benefit of planting selected varieties, of fertilization, and of thorough cultivation to accomplish the same result and at the same time to cover the infested squares with earth. Important and suggestive conclusions were reached which will have an important bearing on modifications of the general system.

COOPERATION WITH THE LOUISIANA CROP PEST COMMISSION.

This cooperation was continued and an energetic attempt was made by the State to check the further advance of the weevil. Five experts were placed at the disposal of the State authorities, and were stationed at various points where the progress of the weevil could best be investigated. While the Louisiana authorities did not succeed in checking the advance of the weevil, many important features of the dissemination of the pest have become well known, and the knowledge gained will be of direct benefit to other States which may at any time attempt to prevent invasion by the pest.

It has been known for some time, as pointed out in publications of the Bureau of Entomology, that the late summer and autumnal work of the cotton-leaf caterpillar is detrimental to the progress of the boll weevil. The early fall destruction of the leaves, when this is at all complete, exposes the boll weevil to the action of the sun, which is inimical to it and deprives it of its food supply. The extensive defoliation of the cotton crop in September and October, 1904, in Texas is in a measure responsible for the late start of the boll weevils in the summer of 1905. In Louisiana this phase of the cotton question is much more marked than in Texas. The cotton caterpillar is present every season, and planters generally poison against it. If the late poisonings are omitted and the caterpillar is allowed to increase, the dense foliage of the cotton plant, which is so abundant in the moist bottom lands of Louisiana, will be done away with and the autumnal ravages of the weevil decidedly checked. In this fact lies possibly a practical measure of considerable importance.

POSSIBILITY OF CONTROLLING THE WEEVIL AT GINS.

It has been evident for some time that gins have been very important factors in disseminating the boll weevil, and during the year this subject has been investigated very carefully. An especially trained expert was employed in this work, and a large number of experiments were carried on with gins in actual operation. Important results were obtained, and a series of recommendations have been sent to all ginners in the infested territory, by the observance of which, and at no very great expense, the danger existing from these establishments may be totally overcome.

INSPECTION OF FARM PRODUCTS QUARANTINED AGAINST BY STATE LAWS.

Nearly all of the cotton-growing States quarantined against certain products of Texas, on account of the danger of introducing the weevil. Some of the rules operating under State laws were too stringent, and at the suggestion of the Bureau they were modified by several States in order to permit the shipment of such products as should be certified by the Bureau as not dangerous.

THE COTTON BOLLWORM.

An investigation of this dangerous insect carried on and concluded within the past few years has resulted in the ascertaining of a complete knowledge of its habits and life history and in the elaboration of a system of treatment which will reduce its ravages in the southern cotton fields to a minimum. The investigation has been concluded and the final report published. The work that is still being carried on with regard to this species is demonstration work undertaken to show cotton planters on a large scale that the recommendations of the Bureau are sound.

THE INTRODUCTION OF BENEFICIAL INSECTS.

Very important results have been gained in the introduction of beneficial insects. One of the most striking of these results is the importation and establishment of the fig-fertilizing insect of south Europe. This was established at Fresno, Cal., with almost immediate results of great interest. A properly planted orchard had existed at that point for some time, but efforts to import the fertilizing insect had failed. As a result of the Department's efforts, the insects were brought over alive and were thoroughly established, enabling, after one year, the production of 10 tons of Smyrna figs of a quality slightly superior to those imported from Europe. The crop has continuously increased, new orchards of Smyrna figs have been set out in parts of California, and a new industry has been established as a result of this importation.

The black scale has for many years been a serious enemy to the citrus and olive crops of California, and although a ladybird enemy of the scale had been imported from Australia, it was efficacious only in certain portions of California, not thriving in other portions where these crops have a great monetary value. After several unsuccessful attempts to establish a parasite, known as *Scutellista cyanea*,

from Italy, it was found that this species also inhabits South Africa, and from that point specimens were introduced which at once took hold in California and have multiplied with such rapidity as to prove of enormous benefit to the growers of oranges, lemons, and olives.

The native home of the San Jose scale was found by one of the experts of the Bureau to be northern China, and from that point he secured specimens of a ladybird, known as *Chilocorus similis*, which were brought to Washington, propagated in numbers, and sent out to different portions of the United States infested by the San Jose scale. The insect does not seem to do well in the Northern States, but has become established in the Southern States. It is prolific and will probably maintain itself and become more and more useful every year. The lime, sulphur, and salt wash and other remedies for the San Jose scale, however, have proved so efficient and are so cheap as to be practically universally adopted, and this adoption takes away the possibility of a very rapid multiplication of the imported ladybird.

An interesting antlike insect, known as the "kelep," was discovered in 1904 in Guatemala by an officer of the Bureau of Plant Industry, and was found to be such an important enemy of the cotton boll weevil in that country as to hold it distinctly in check and to permit the cultivation of cotton where otherwise it would be impossible on account of the weevil. Colonies of this insect have been introduced into the United States, and while it is as yet impossible to state whether it will establish itself and become an important feature in cotton cultivation, it promises good results, and the fact has at least been established that in tropical regions it may be used to very great advantage.

A systematic effort has been begun within the past summer to import the European and Japanese natural enemies of the gypsy moth and the brown-tail moth. The Chief of the Bureau visited Europe and secured very many parasites and sent them to Massachusetts, where they are being cared for. The trip has demonstrated effectually that the natural enemies of these two important insect pests may be easily brought from Europe to the infested territory in the United States, but it is as yet too early to state whether they will establish themselves in such a way as to afford relief. The outlook, however, is hopeful.

THE SENDING OF USEFUL INSECTS ABROAD.

During this period many sendings of important parasitic and predatory insects have been made to foreign countries where it was thought they would be of assistance in warfare against injurious insects. The most striking instance of the value of this work occurred in 1898, when the orange groves of Portugal were threatened with extinction by the ravages of the white scale. The officials of the Portuguese department of agriculture appealed for assistance, and through the cooperation of the State board of horticulture of California specimens of *Novius cardinalis*, the ladybird enemy of the white scale, imported from Australia into California by an employee of the Bureau some years previously, were secured. The Entomologist had these specimens carried in the refrigerating compartment of

a steamer to Portugal. The success of the experiment was almost immediate and very great, and the scale was practically annihilated in a little more than a year.

Parasites of American scale insects have been, and are still being, sent to the official entomologists of Italy, France, and other countries, and good results are constantly being secured. No results, however, have as yet proved as striking as those in Portugal, just described.

WORK ON SCALE INSECTS.

Careful investigations have been made into the habits and life histories of very many species of injurious scale insects, and the Bureau has built up what is probably the largest collection of these insects in existence. Its publications on the life histories of these insects are standard, and its especial publications on the San Jose scale are the basis of all of our knowledge of this important pest. The work of the Bureau on remedies for scales has been very extensive, and for the past eight years has formed an important part of the output of the Bureau. Nearly all of the standard remedies against this class of insects are the result of these labors.

When various foreign governments passed regulations forbidding the importation of American plants and fruits, on account of the danger of introducing the San Jose scale, some of the edicts went too far, and forbade the importation of unpeeled American dried fruits. An important investigation was therefore carried on to determine the effect on the San Jose scale of the different methods in use in this country in drying fruits for exportation. The results showed the unnecessary nature of the foreign regulations, not a single scale having been found which showed the slightest signs of life after drying by any of the processes in use. The result of this investigation was of distinct benefit to dried-fruit exporters, and necessitated the revision of the laws of several foreign countries.

INSECTS INJURIOUS TO FRUIT AND FRUIT TREES.

While scale insects form many of the important enemies of orchards, there are many others which have also been investigated. In 1901 the necessity developed for a careful investigation of the codling moth in the Northwestern States, where it seemed the remedies applied in the East were not effective. It was supposed that the difference in climatic conditions had brought about a change in the life history and habits of the insect which rendered eastern remedies less useful. Consequently a thorough investigation was carried on, which lasted for three years and cleared up all doubtful points in life-history conditions as applied to the Northwest, and resulted in the publication of results which have been of great value to the fruit growers of that region. In the course of this investigation demonstration work was carried on in one of the largest orchards in Idaho, and fruit growers from different parts of Washington, Oregon, and Idaho were invited to inspect the methods and the results. Many did so, and were convinced of the value of the work. Fruit growers in California and other States have written to the Department stating that their operations had been rendered much more profitable as the result of this investigation.

While more or less work against fruit insects has been constantly carried on, an effort has been organized to make a very especial and widespread investigation of this class of pests, and several experts have been assigned to the work, which is now being carried forward on a broad scale.

INSECTS DAMAGING FORESTS.

Beginning with 1899, an investigation of the damage to forests by the work of insects was begun by the Bureau of Entomology in cooperation with the Bureau of Forestry. The importance of these investigations was immediately recognized, and they have been extended until they form a distinct section of the Bureau's work. Many important results have been reached. In 1902, for example, great loss of pine timber, to an amount of more than 226,000,000 feet (board measure), was found to have resulted in the Black Hills Forest Reserve from the work of a bark beetle mining under the bark of living trees.

An investigation resulted in the discovery of practical methods by which the ravages may be entirely checked. The cost of carrying out the recommendations is not great, and the investigation means not only the saving of threatened loss of forest property valued at many millions of dollars, but also the prevention of the crippling of great mining and commercial enterprises representing many more millions. In the course of this work especial cooperation has been entered into with lumbering companies, manufacturers of wooden articles of trade, importers of exotic woods, and forest rangers, which is rendering the work more efficient and bringing it close to the people directly interested in its results.

INSECTS INJURIOUS TO STORED FOODS.

An extended investigation has been made of insects injurious to stored foods. The full life history of practically every species known has been worked out, extensive experimental work has been carried on with remedies, and a thoroughly practical and efficient system of fighting these insects has been ascertained. The publications of the Bureau on this class of insects have been in great demand among grain and milling men, and the efficacy of the Bureau's recommendations is undoubted. The number of species of insects which infest stored food supplies is very great, and the labor of working out the full life histories has been prolonged and arduous.

INSECTS WHICH CARRY DISEASE.

Special and important studies have been made of certain of the insects known to carry disease, with results of great importance. The publications of the Bureau on the subject of mosquitoes have been in great demand by members of the medical profession, and to a large extent the knowledge we have in this country of the mosquitoes which carry malaria has been due to the work of this Bureau. Important studies have also been made of the yellow-fever mosquito, and the quarantine regulations of the Public Health and Marine-Hospital Service, in the recent yellow-fever emergency, are based on

the results of this work. The Bureau was a pioneer in work against mosquitoes, and its constant reiteration of the possibility of controlling mosquitoes has been in a large measure the cause of the large-scale antimosquito work now being carried on.

The Bureau has also paid special attention to the study of the house fly, especially in relation to its agency in the carriage of disease. These studies revealed the very great danger that exists of the carriage of typhoid fever by the house fly and by certain other insects. This investigation is the only one of its kind that has ever been carried on, and its results are considered of great value by the medical profession.

INSECTS AFFECTING LIVE STOCK AND FIELD CROPS.

Studies of the insects affecting live stock have been continued, and new material of value has been published about several of the more important. An investigation into the natural history of the cattle tick is now being carried on, which will have an important bearing on the cattle industry of the South, since upon such an investigation may depend the important question of rotation in pasturage to do away with the so-called Texas, or splenetic, fever.

Careful studies have been made of a number of the principal field-crop enemies of the country, and as a result special bulletins were published on the Hessian fly, on the chinch bug, and on the general subject of insects injurious to grains and grasses.

SILK CULTURE.

In 1902 the Bureau began once more, after an interruption of a number of years, a systematic effort to introduce the culture of the domestic silkworm into the United States, and this effort has continued since that time. Guaranteed eggs were purchased in Italy, mulberry cuttings of best varieties were also purchased abroad, manuals of instruction in the raising of silkworms and in the care of silkworm food plants were issued, and two silk reels purchased in France. Two skilled French reelers were brought over from France, and remained in Washington for some months instructing several American girls in the process of reeling thread from cocoons. The eggs purchased abroad were sent, on application, to all persons in the United States who possessed mulberry trees, upon the leaves of which the worms are fed. Persons not possessing mulberry trees were supplied with cuttings, rooted seedlings, or seed of the mulberry.

Following the instructions given in the manuals, the correspondents of the Department raised their silkworms, harvested their cocoons, and sent them to the Department, for which they were paid the current European prices. The cocoons were then reeled by the Department's employees, and the silk resulting will eventually be sold. This process has been repeated each year. The establishment of commercial filatures in the United States without a guaranteed crop of cocoons is obviously an impossibility. Therefore it has been the aim of the Department to get mulberry trees planted in favorable situations, to educate as many people as possible in the care of the worms, and, by purchasing the cocoons, to keep its correspondents interested and engaged in the culture until the time comes that the establishment

of commercial filatures will be possible. The recent invention of silk reels which greatly reduce the cost of reeling and the establishment of colonies of Italians and others skilled in silk culture at different places in the United States seem to point to the establishment of the industry before long.

WORK IN APICULTURE.

There have been carried on during the period mentioned certain investigations in bee culture which have in the past year become extended and which promise to be of much assistance to the keepers of bees in the United States. The lines of work being carried out are principally in the studies of bee diseases, in the investigation of new forage crops, and in the introduction and establishment of valuable races of bees from other parts of the world.

SAVING FROM INSECT LOSSES RESULTING FROM THE WORK OF THE BUREAU.

Some indication of the cash value of the work outlined should be given.

The boll weevil, which in 1904 caused the destruction of $22,000,000 worth of cotton in Texas, did not prevent, in that year, the production of the largest cotton crop grown in this State, and the very regions where the crop in the earlier years of the invasion of the weevil had been utterly destroyed produced cotton this year in very profitable quantities. The enormous cotton crop of Texas for 1904 affords an evidence of the value of the methods of control elaborated by this Bureau. In the case of the bollworm, which has caused a loss annually of about $12,000,000 throughout the cotton-producing area of the South, the careful experimental field work of this Bureau has shown means of preventing a very large percentage of this loss, and these means of control are being gradually adopted, to the great profit of cotton growers.

The methods of controlling the San Jose scale, the most important pest of the deciduous fruit trees in this country, are so effective that commercial orchard growers no longer fear this scale insect. The proof of the efficiency of these methods and their general exploitation have largely come about within the last eight years, and chiefly as the result of the experimentation conducted by the Bureau of Entomology. The saving effected amounts not only to millions of dollars in value of the fruit product, but also to the very life itself of the trees and the continuance of large commercial orchard enterprises. The cost per tree of this treatment is not heavy, but it is expected that this charge will be still further reduced by the importation of natural enemies of the San Jose scale.

The saving which has already resulted from work against the insect enemies of forests is illustrated by the outcome of the investigation in the infested Black Hills district. Here a loss of more than $10,000,000 worth of timber occurred in a single year. Simple and effective means of preventing repetitions of such losses were discovered.

In the case of stored products, such as cereals, tobacco, and woolen and manufactured goods, the processes of fumigation with bisulphid of carbon and hydrocyanic-acid gas, which have come into general use during the last eight years, are preventing enormous

losses every year. The annual loss in stored products is probably fully 5 per cent, which gives the enormous total of $100,000,000, and certainly one-half of this loss can be prevented by the proper use of the fumigants mentioned. These same fumigants are also coming into very common use for the eradication of insect pests in houses and stores, and the saving in this field is already very great.

The lessening of the diseases due to mosquitoes and house flies, such as malaria, typhoid fever, and yellow fever, has been very greatly assisted by the investigations of the breeding habits and means of controlling these pests conducted by the Chief of the Bureau of Entomology. The cash value of such work is almost beyond computation when the stagnation of business enterprises and general commerce which results from epidemics of yellow fever and, to a less extent, of typhoid fever and malaria, is considered. The same is true of insect parasites and disease conveyors affecting domestic animals.

Many other items of equal importance could be added relating to field-crop insects and insect enemies of fruits and other farm and orchard products. In the case of the latter more particularly the benefits resulting from the work of the last eight years have been in continuation and accentuation of work of earlier years, but a good share of the present benefits must be ascribed to the increased effectiveness and knowledge gained by the more recent investigations.

BUREAU OF BIOLOGICAL SURVEY.

The work of the Biological Survey began in 1885, and at first consisted chiefly of the study of the food habits of birds and mammals for the purpose of determining their exact relations to agriculture.

A second line of investigation was soon added, for it was perceived that the distribution areas of indigenous plants and animals were closely correlated with those of cultivated crops. The determination of the boundaries of the natural life zones of the United States and the corresponding crop zones, therefore, became an important division of the work of the Survey.

In 1900, as a result of the passage of certain Federal laws, a third division of the work, that of game protection and introduction, became necessary.

The work of the Survey is now pursued along these three distinct lines.

DETERMINATION OF LIFE ZONES AND CROP ZONES.

Early attempts at agriculture in the United States were necessarily almost wholly experimental, and the particular locality, climate, and conditions suited to special crops were ascertained only after many and costly individual trials. The chief purpose of a biological survey of the several States is to ascertain and make known, by means of maps and reports, the boundaries of the natural life zones, together with the physiographic and climatic conditions that determine them. The life zones of a State once ascertained with precision, the farmer is greatly aided in selecting the crop best adapted to his own district and, what is scarcely less important, in avoiding crops unsuited to it. Thus the uncertainty and cost of farming experiments may be greatly reduced.

In a publication entitled "Life Zones and Crop Zones of the United States" the life zones of the country were defined and mapped, and the adaptation of various crops to the several zones were indicated so far as the data collected to 1898 permitted. Future and more detailed work in the several States will enable the life zones to be defined with greater precision and the selection of crops to be made with great accuracy.

Biological field work in the State of Texas, which was begun in 1899, has been completed and final reports are being prepared. A report already published contains an account of all the mammals and reptiles of the State, with especial reference to their economic status. The life zones of the State are defined and, as a means of identifying them, the mammals, birds, reptiles, and plants characteristic of each zone are specified.

A biological survey of California was begun in 1891 and is far advanced toward completion. Its size, peculiarly diversified surface, its mountains and deserts, and its climatic conditions render California a difficult field for biological surveys, while the varied resources of the State and its immense agricultural interests make the work exceedingly important.

Work in outlining and mapping the life zones of Colorado and New Mexico along lines similar to those indicated above was begun in 1904, and is progressing satisfactorily.

Preliminary work has been carried on in most of the States whose agricultural interests are large, and detailed surveys of the several States will be undertaken as rapidly as means and the exigencies of work already begun permit.

Investigations in Alaska were begun in 1899, when the increase of population and growing commercial importance attracted attention to that Territory. Little accurate information was then available regarding the game and fur-bearing animals which add so largely to the resources of the region. Moreover, important problems connected with the study of the life zones and crop zones of the United States could not be solved satisfactorily without contributive data from more northern regions. An assistant, therefore, has been engaged in field work in Alaska each season since 1898, excepting 1901 and 1905, and the results are found to have an important bearing upon many phases of the work of the Biological Survey. Of particular value has been the direct knowledge of local conditions thus obtained, which is necessary for use in connection with the administration of the Federal game law of Alaska. A part of the results of these investigations has been published in three faunal reports. Other reports of similar nature are in preparation.

From 1900 to 1903 a small party of the Survey was engaged in studying the geographic distribution of birds, mammals, and plants in the Boreal and Arctic zones of Canada, particularly for the purpose of connecting the results of work in Alaska and the home territory by means of investigations in the intervening regions. Part of the results appeared in 1902 under the title "A Biological Investigation of the Hudson Bay Region," and a report upon the work in the Athabasca and Mackenzie valleys is nearly ready for publication.

In 1897 the work of the Survey was extended into Mexico for the purpose of tracing into that country the life zones of the United

States, to determine the northern limits of the tropical zone of Mexico, to ascertain its extent within the United States, and to obtain a knowledge of the distribution, abundance, and habits in Mexico of American plants, birds, and mammals. A general zone map of Mexico has been completed, and a large amount of scientific and economic data is on file.

ECONOMIC ORNITHOLOGY.

This section of the Biological Survey is engaged in the study of birds in their various relations to man. Two principal lines of investigation are followed. In the first, the habits of birds are studied in the field, especially with reference to their food. Orchards, gardens, and grain fields are visited in order to determine whether birds damage crops, attack insects, both injurious and beneficial species, and to what extent they feed upon wild fruits and weed seeds. In this field study it is desired to enlist the cooperation of every cultivator of the soil. In the second, stomachs of birds are examined in the laboratory and their contents tabulated. In addition to the stomachs collected by our own assistants, many are obtained from ornithologists throughout the country. From 1885 to 1897, 24,000 stomachs had been collected, and of these about 12,000 had been examined. Since then stomachs have been received at an average rate of more than 4,000 annually, and the number is constantly increasing from year to year. The total number now on hand is about 66,000.

In 1903 an article was published upon the "Economic Value of the Bobwhite," in which the salient points in the food habits of this valuable bird were brought out. Attention was paid also to birds in their relation to bee culture, as complaints had been made that birds destroy bees.

In 1904 a preliminary article upon the work in California, begun in 1901, was published, in which the conditions attending fruit growing in that State were briefly reviewed and the birds of economic interest were discussed.

The constantly increasing ravages of the cotton boll weevil have created an urgent demand for accurate knowledge of the food habits of insectivorous birds in the cotton districts, and during the past two seasons assistants of the Biological Survey have made a special study of birds in relation to the destruction of the boll weevil. As a result of these investigations a bulletin on the subject has been published, and considerable additional data have been gathered.

ECONOMIC MAMMALOGY.

In connection with the study of the geographic distribution of mammals, field naturalists are instructed to observe particularly the food habits of each species, to secure data concerning their relation to the farmer, whether beneficial or injurious. Many stomachs have been examined and others are now on hand awaiting examination.

During the past eight years experiments in the use of poisons and other means for destroying noxious mammals have been made, both in the laboratory and in the field. Rats, prairie dogs, ground squirrels, rabbits, field mice, and pocket gophers have been the subjects of these experiments.

Special reports on prairie dogs, ground squirrels, pocket gophers, jack rabbits, and coyotes have been published, and investigations concerning these and other mammal pests are being continued. A great mass of notes on the habits of mammals has been accumulated, and reports on the economic relations of field mice, beavers, wolves, and skunks are now in course of preparation.

Experiments with fences to protect sheep and other domestic animals from the depredations of coyotes, dogs, and other predatory animals are in progress in cooperation with farmers in Oklahoma and Kansas.

GAME PROTECTION AND INTRODUCTION.

The duties of the section of the Biological Survey devoted to supervision of game protection and introduction grow out of three acts of Congress: Act of May 25, 1900, commonly known as the Lacey Act, requiring supervision of importations of wild birds and animals from foreign countries and of the preservation of the birds and game of the United States; act of June 3, 1902, requiring supervision of the importation of eggs of game birds; and act of June 7, 1902, requiring supervision of the preservation of the game of Alaska.

ENTRY OF FOREIGN BIRDS AND ANIMALS.

Since the passage of the Lacey Act, May 25, 1900, constant vigilance has been exercised to prevent the entry of injurious species of birds and mammals. The annual importations of birds and animals are large, and include canaries and miscellaneous cage birds, shipped mainly from Germany, Australia, China, and Japan; a few pheasants and other game birds, for liberation or confinement in aviaries, and rare birds and animals for the various zoological parks of the country, brought in chiefly at New York and San Francisco; pheasants for aviaries imported from Canada at ports along the northern border, and parrots and monkeys from Mexico and Central America, entered at southern ports. Inspectors have been appointed at seven of the principal ports to examine all large shipments or such as may possibly contain injurious species.

During the five years ending June 30, 1905, 1,591 permits have been issued for the entry of 1,006,964 birds (principally canaries), 2,846 mammals, and 38 reptiles, and 13 for the entry of 6,500 eggs of game birds. Of the consignments entered 402 have been inspected. To prevent inconvenience in cases where no danger exists, the requirement of permits for reptiles and a number of species of well-known mammals was removed at the end of the first quarter of the operation of the law. So far as is known, no injurious species have been entered. Seven mongooses, 54 flying foxes or fruit-eating bats, 1 kohlmeise, 15 blaumeisen, and 2 starlings have been refused entry, and either killed or reshipped to the original port of shipment. Six keas were refused entry at Honolulu.

INTERSTATE COMMERCE IN GAME.

Through cooperation with the Department of Justice and game officials throughout the United States 166 violations of the Lacey Act, involving the shipment of 24,424 head of game and 2,608 plume birds, have been investigated, and 49 convictions have resulted. Of

the convictions 30 were secured in Federal and 19 in State courts. In addition to securing convictions for violations of law, great effort has been made to secure observance of both the Federal and State laws. Summaries of the principal provisions of the game laws of the United States and Canada have been issued annually and widely distributed, and several publications on special subjects have been prepared.

Aid in framing satisfactory laws has been extended to State officials and legislators; the conditions of illegal traffic in game have been carefully studied and in special cases have received personal investigation, and copious correspondence and many personal interviews have been had with State game officials with a view to securing better legislation and more rigid observance of the laws. To this phase of the Department's duties railroad and express companies have lent cordial and valuable cooperation.

PROTECTION OF GAME IN ALASKA.

Thorough supervision of game protection in Alaska has not been possible because of the limited means available for this purpose. With the cordial cooperation, however, of the Treasury Department, through its customs officials at Port Townsend, Seattle, San Francisco, and various points in Alaska, a rigid surveillance has been maintained of all exports of game trophies and specimens from the Territory. During the three years the law has been in operation 155 permits for such exports have been issued, under which 93 trophies were shipped, including heads of 29 moose, 38 sheep, and 3 caribou, as well as several consignments of specimens for scientific purposes. Owing to expressed local dissatisfaction with the law a bill materially modifying it was introduced into Congress in the session of 1904–5. For this reason it was deemed desirable to further restrict the issue of permits, and very few have been granted during the present year.

BIRD RESERVATIONS.

It is well known that certain favorable localities form breeding places for large colonies of birds. Such localities offer tempting marks to those who gather eggs or plumage for commercial purposes, and if these depredations are unchecked complete extermination of certain species is sure to result. Within the past three years three such breeding grounds have been converted by the President into bird reservations. Pelican Island, a breeding resort for pelicans, off the coast of Florida, was so set apart on March 14, 1903; Breton Island and two smaller islands off the coast of Louisiana, a breeding ground for gulls and terns and a wintering resort for hundreds of thousands of ducks, were reserved on October 4, 1904, and four small islands in Stump Lake, North Dakota, which form a breeding colony for many ducks and other water birds, on March 9, 1905. The Department cooperates in the establishment and regulation of these reservations.

ACCOUNTS AND DISBURSEMENTS.

In this Department the keeping of accounts and disbursement of funds are assigned to the Division of Accounts and Disbursements. The report of the Chief shows the work of the Division to be in good

shape. Of the $6,094,540 appropriated by Congress about $800,000 remained unexpended at the close of the fiscal year, but most of this sum was covered by liabilities. The accounts for 1903 have been finally closed, and an unexpended balance for that year of $281,615.16 has been covered into the Treasury.

The estimates for the current fiscal year (1906) amounted to $5,697,810, of which $1,388,490 was for the Weather Bureau. It should be stated that the estimates and appropriations mentioned here do not in any case include the $720,000 annually appropriated for the support of the State Agricultural experiment stations. Congress made small reductions in many of the estimates, but large increases in several others, so that the total appropriations exceed the estimates by $292,880. This increase does not include $190,000 appropriated for continuing the cotton boll weevil investigations, nor $950,000 appropriated for the new Department buildings, which subjects were not included in the Department's estimates. The large apparent increase in appropriations for salaries resulted mainly from the fact that employees formerly paid from "lump-sum" funds have been placed on statutory rolls. The largest actual increase was one of $330,180 in the appropriation for the Forest Service, which resulted chiefly from the transfer of the National forest reserves from the Interior Department to this Department.

DIVISION OF PUBLICATIONS.

THE WORK OF PUBLICATION.

At this time, when the publication work of the Government is the subject of considerable discussion and not a little criticism, it is meet and proper that this branch of the work of this Department should be presented clearly to the public.

DIFFUSION OF INFORMATION AUTHORIZED BY LAW.

In the organic law which created this Department it was made the duty of the head of the Department to diffuse just as much as to acquire information of value to agriculture. While the Secretary is authorized to diffuse this information by all means at his command, the most obvious method, the most economical, the most available, is to put this information in print. Inasmuch as the acquisition of any information of value to agriculture imposes on the Secretary the duty of making it public, it is obvious that the work of publication must grow with the growth of the Department. Every line of inquiry authorized and undertaken by the Department implies necessarily the publication of results.

GROWTH OF PUBLICATION WORK.

Under the circumstances it is not surprising to find that whereas in 1897 the total number of publications was 424, in 1905 the total number was 1,072, and whereas in 1897 the number of printed pages of original matter was 11,715, in 1905 the number of printed pages of original matter was 20,000. The unavoidable growth of the publication work of the Department has been from the first the subject

of my earnest consideration, and every effort has been made toward economy consistent with the duty presented above of making speedily available to the public whatever valuable information has been acquired. The practice has been adopted of restricting the size of the editions as much as possible with a view to preventing the accumulation of undistributed publications, and reprints have been resorted to from time to time in the case of publications for which a continuous demand was found to exist. Especially has this been true of publications of a technical character.

WATCHFULNESS IN THE DISTRIBUTION OF PUBLICATIONS.

Objections have been urged against the publication and distribution by this Department of bulletins of a technical character. The answer to these objections is that many of our publications are unavoidably scientific or technical in their character, being the practical record of scientific investigations by scientific men, the value of whose conclusions must necessarily bear the scrutiny of scientific investigators the world over. The elimination of all scientific terms and language from such reports is impossible. In this connection it is well to call attention to the fact that the average edition of these more technical or scientific publications is about 2,000 copies, and distribution to others than specialists, libraries, and educational institutions is very insignificant. For popular use the great bulk of publications has appeared in the form of inexpensive pamphlets, such as, for instance, the Farmers' Bulletins, which constitute nearly one-half of the total number of publications issued. Every possible care is taken in the distribution of our documents to minimize the waste inseparable from any system of gratuitous distribution.

The permanent lists of the several Bureaus, Divisions, and Offices are kept within as narrow bounds as possible, the policy of the Department being to widely advertise its publications as they appear and confine the distribution almost entirely to persons applying for them. A fair test of the demand for the Department publications is furnished in the records of the Superintendent of Documents, from whom the publications of the Department may be obtained by purchase. This official reports the sale during the year 1905 of 68,000 Government publications, of which more than 38,000 were publications of this Department.

FARMERS' BULLETINS.

Of the Farmers' Bulletins there were distributed upon the orders of Senators, Representatives, and Delegates in Congress 4,782,643 copies during the past year. Unlike the Yearbook and other publications of the Department especially ordered by Congress, the Farmers' Bulletins are not delivered to the folding rooms of the Senate and House, subject to the order of members, but are held in this Department and are distributed mainly under addressed franks furnished by them. Moreover, under the law providing for this class of publications, all those remaining on hand of the 80 per cent provided for the use of Congress revert to the Department and are thus made available for redistribution.

One feature of the Congressional distribution deserves to be specially noted, and that is that the proportion of Senators, Representatives, and Delegates failing to use their quotas is very much less than heretofore. The fact that the number of Farmers' Bulletins left over from the 1st of July last was less than the year previous by over a million copies has resulted in a reduction of the Congressional quota of the current year from 15,000 to 14,000 copies.

THE YEARBOOK.

The Yearbook of the Department is published annually in an edition of 500,000 copies, as provided by the act governing the public printing and binding approved January 12, 1895. Of this enormous edition, however, but 30,000 copies are placed at the disposal of the Secretary of Agriculture, and of this number 27,000 or 28,000 are reserved and sent to active correspondents who have in some way earned, by actual services rendered, a right to such recognition, leaving the number in the hands of the Secretary for miscellaneous distribution but about 2,000. It may be stated here that the total number reserved for the Department, namely, 30,000, is just the same as it was twenty years ago, when the total edition was 300,000. Of the 200,000 additional copies printed since then not a single copy finds its way to the Department itself, and every business day of the year scores of letters are written by the Department explaining to applicants, including even those who have certain claims upon the Department, our inability to supply them with the Yearbook; this notwithstanding that, as has been recently shown, thousands of copies remain stored in the folding rooms of the Senate and House undistributed and unavailable—a condition of things, however, which it is obvious the head of this Department is powerless to affect. Investigation would probably show that a similar condition exists in regard to many other of the publications printed by order of Congress and reserving a considerable quota for Congressional use.

A FRUITFUL SOURCE OF EXTRAVAGANCE.

The provision of the law already cited, which limits to an edition of 1,000 copies all publications of this Department exceeding in size 100 octavo pages, has proved a fruitful source of extravagance. While designed, undoubtedly, merely to effect the limitation of our publications to small-sized pamphlets, a limitation which it has been the general policy of the Department to encourage, the actual effect has been to compel application to Congress for a larger edition, such action almost invariably involving provision for several thousand copies for the use of members, and this even in cases such as the Beet Sugar Reports, where only a minority of the members was interested in the subject. Some of these publications have been printed and reprinted by order of Congress, such as the Report on the Diseases of the Horse, and the Report on Diseases of Cattle, and others, the total editions in some cases aggregating hundreds of thousands of copies, where no application for such provision was ever made by this Department, and in many cases where no provision was made for a single copy for the use of the Department.

From the foregoing it is obvious that in the matter of printing this Department occupies a unique position, it being the Department's special duty to print, and to print abundantly; that in the aggregate nearly one-half of all the copies of its publications are issued subject to the order of Senators and Representatives; that economy is practiced both as to style of publication and in the manner of distribution; that a determined effort is made to restrict the number of copies of the publications of the Department to the actual demand existing for them.

The total number of documents distributed was 12,089,653 copies, the actual mailing, correspondence, and clerical work in connection therewith involving work of considerable magnitude and difficulty. It is gratifying to report, however, that the distribution has been unusually prompt, the average length of time required in filling miscellaneous requests for publications having been reduced to an average of two days. This result has been rendered possible largely owing to increased facilities and improved service.

DEMAND FOR PUBLICATIONS FROM EDUCATIONAL INSTITUTIONS.

Unfortunately, under the limitations imposed upon the Department either by the printing law or the available appropriations, the actual demand for publications is far beyond our ability to supply. A very large proportion of the correspondence of the Division of Publications consists of letters explaining our refusal to comply with what seem to be perfectly reasonable requests for Department publications. One feature of this demand deserves special notice. Of late years the demand made upon us for publications in bulk for class work in institutions of learning, for use at farmers' institutes, and from others of the very numerous and rapidly increasing agencies seeking to promote agricultural education has multiplied tenfold. While this is a most encouraging feature from an educational and sociological point of view, it is truly discouraging to be able to meet only a very small proportion of these demands, and rarely to be able to comply with any of them in their entirety. It is of no use to allege the existence in large numbers of undistributed publications of this Department in the folding rooms of the Senate and House, this supply being entirely beyond the reach of the Department, and serving only, as its existence is reported from time to time in the public press, to stimulate demands upon the Department and to make more difficult to the minds of many applicants our explanations of inability to satisfy their requests.

REPORT TO JOINT COMMITTEE ON PRINTING.

This Department furnished to the chairman of the Joint Committee on Printing of the Senate and House of Representatives a statement showing the publications issued by this Department during the fourteen years ended June 30, 1905, giving the number of copies of each edition printed, the cost of each publication, the manner of distribution, and the number of copies on hand July 1, accompanied by replies to the several interrogatories contained in the request for the information furnished, together with certain recommendations in regard to the public printing and binding.

BUREAU OF STATISTICS.

THE DEVELOPMENT OF THE BUREAU.

The statistical work of the Department of Agriculture, begun in 1862, has developed into wide use in serving as a basis in establishing prices of farm products. The relations and mutual interests of agriculture, commerce, and manufactures, and of consumers of farm products, are now so vast and so complex that the necessity of issuing impartial crop reports by this Bureau is generally recognized. The needs of all interests require that there be published at frequent intervals during the crop season by a disinterested agency reliable information of the acreage, condition, production, and value of the principal crops, also reports of live stock, by States and by total crop areas, to serve as a legitimate basis for current prices. When this work was begun the value of farms and farm equipment was about $7,000,000,000; now it has reached nearly three times that amount. Of the $5,000,000,000 worth of annual farm products a much larger per cent than formerly is sold off the farm and enters commerce and manufactures.

The industries depending on agriculture have grown to vast proportions, and not only manufactures, but transportation and mercantile business are in more sensitive touch with the products the farmer can sell and with his power to purchase than ever before. Trade has become vastly more complex, partly owing to the rapid development of reselling on close margins to take advantage of fluctuations in prices, and of dealing in futures and in options. The development of organizations to fix prices and of other organizations to force temporary changes in prices, giving unnatural advantages to price manipulators, has led the public more and more to recognize the need for a strong and impartial agency to make comprehensive reports of actual facts relating to prospective crops and yields, that all concerned may know how to buy and sell.

THREE CLASSES OF CROP REPORTS.

There are three classes of statistical reports of agricultural products prepared by the Federal Government.

(1) The census of agriculture, issued every tenth year by the Census Bureau of the Department of Commerce and Labor, giving a census count of all acreages and yields of crops and reports concerning farm animals, the last census having given the figures collected in 1900 of the crops and live stock for 1899. The reports of the Census Bureau, coming out one year in ten, after the crop of that year is harvested and sold, serve only as a basis and a check, making it possible for the Bureau of Statistics of this Department during the succeeding ten years to more accurately estimate amounts of crops in prospect or amounts actually harvested. The reports of this Bureau could be made more accurate if an agricultural census were taken every five years instead of every ten, providing bases of comparison not so far removed.

(2) The monthly and annual reports by the Bureau of statistics of agriculture, giving acreage, condition, yields, and prices of crops, and reports of live stock, serve as bases for current prices.

(3) These monthly reports, expressed numerically for entire crop areas, serve also as bases for more frequent reports of changed conditions caused by marked weather changes as reported by the Weather Bureau of this Department.

CONDITIONS GOVERNING THE MAKING OF CROP REPORTS.

Various conditions govern the making of reports which influence the prices of farm products. Government crop reports deal mainly with products which are not quickly perishable. The prices of these are fixed at frequent intervals—often daily—by large market organizations, which gather information from the entire area as to the probable amount of products available, positions of any of the products on the routes of commercial movement, and the demand for the products. About these markets there are agencies which may combine to raise or lower prices artificially and temporarily, often so manipulating the prices as to destroy the needed confidence in merchandising the products, and resulting in unwarrantably large "handling charges" from the time the products leave the producer till they reach the consumer.

The producer should have as good a central crop-reporting agency as the buyer. Since his business is divided into many small noncooperative units, he can not have this without Government aid. The manufacturer, the dealer in actual products, and the consumer also need protection from the speculative manipulation of agencies organized to modify prices temporarily for their own advantage, and the main purpose of crop reports is that the whole people may be benefited by a knowledge of the actual facts which may influence current prices.

A knowledge which covers only parts of the area of a given crop may be misleading, because to judge for the entire area from conditions in some localities may give wrong results; hence the producer and others interested need a knowledge of the crop of the entire area expressed as a total. Reports covering part of an area, or covering the area definitely only in parts, may be used by self-interested crop reporting agencies to mislead. The reporting agency, in order to enable those interested as producers, consumers, or dealers to recognize the conditions in the entire crop area, must resolve all the facts into quantitative statements, preferably a single numerical statement, as of yield for the entire area, and the market must then resolve the balances between supply and demand into current prices. Only by "weighting" reports from each district, that is, by giving to each partial report only that arithmetical weight which the acreage in the area covered by the partial report demands and assembling the whole into one statement, can the crop estimator accurately report for the whole area. Such definite forms of statement have the advantage of placing the reporting agency under responsibility to attain accuracy, also of being easily interpreted by all parties; and they are capable of comparison from month to month or from year to year or with averages, as for the previous ten years.

The Bureau of Statistics, acting as a disinterested agency, has assumed the task of keeping the farmers, the dealers, and the users of farm products informed, and the general acceptance of its estimates

in deciding prices is the only proof needed to establish the reasonable accuracy of these estimates. Its reports of conditions and its estimates used by markets in establishing current prices have become a necessary part of our domestic trade and our foreign business. These monthly reports serve as guides to all intermediate reports from whatever source, which without this monthly basis would be too local and partial to be of much value, and enable producers to know the facts as to the promise of prices for their crops, that false reports—which were common before the Government arranged to give the facts as nearly as they could be ascertained—may not mislead them into early sales at prices purposely made too low.

METHODS OF CROP REPORTING.

The Bureau of Statistics issues each month detailed reports relating to agricultural conditions throughout the United States, the data upon which these statements are based being obtained through a special field service, a corps of State statistical agents, and through a very large body of voluntary correspondents composed of the following classes: County correspondents, township correspondents, individual farmers, and special cotton correspondents.

A special field service is composed of ten traveling agents, each assigned to report for a given group of States. These are especially qualified by statistical training and practical knowledge of the crops. They systematically travel over the districts assigned them, carefully note the development of each crop, and keep in close touch with best-informed opinion; and they render written and telegraphic reports monthly and at such other times as required.

The State statistical agents are paid agents located in 43 of the States. Each of these reports for his State and maintains a corps of correspondents entirely independent of those reporting directly to the Department at Washington. These State statistical aids report each month directly to the State agent on schedules furnished them. Their reports are then tabulated and weighted according to the relative yield or area of the given crop in each county represented, and are summarized for the use of the State agent. Then he coordinates and analyzes them in the light of his own knowledge of conditions derived from personal observation and other sources, and prepares his monthly and other written and telegraphic reports to the Department.

There are in the United States approximately 2,700 counties of agricultural importance. In each of these counties the Department has a county correspondent, who maintains an organization of several assistants. These county correspondents are selected with especial reference to their qualifications, and constitute an efficient branch of the crop-reporting service. They make the county the geographical unit of their reports, and after obtaining data each month from their assistants and supplementing this with information obtained from their own observation and knowledge they report directly to the Department at Washington.

In the townships and voting precincts in the United States in which farming operations are extensively carried on the Department has township correspondents who make the township or precinct the basis of the reports which they send directly to the Bureau of Statistics each month.

Finally, at the end of the growing season a large number of individual farmers and planters report on the results of their own individual farming operations during the year.

With regard to cotton, the information secured from all the foregoing sources is supplemented by that furnished by special cotton correspondents, embracing a large number of persons intimately concerned in the cotton industry.

SCOPE OF CROP REPORTS.

Eleven reports on the principal crops are received yearly from each of the special field agents, State statistical agents, county correspondents, and township correspondents, and one report relating to the acreage and production of general crops is received during the year from individual farmers.

Six special cotton reports are received during the growing season from the special field agents, from the State statistical agents, from the county correspondents, and from township correspondents; and the first and last of these reports are supplemented by returns from individual farmers, special correspondents, and a list of cotton ginners supplied through the courtesy of the Census Bureau, Department of Commerce and Labor.

HANDLING THE CROP REPORTS.

It has been found necessary during the past year to thoroughly recast our methods of handling the crop reports. A gross breach of trust on the part of one of the responsible employees of the Bureau of Statistics, involving the misuse for private gain of the confidential reports to which this person had access, revealed a weak link in the chain. An entirely new method of handling the reports was devised, which it is believed makes it practically impossible for such a breach of confidence to occur in the future.

In the case referred to the prompt dismissal of the culpable official was followed by the submission to the Department of Justice of the whole matter, with a view to the prosecution of the guilty party or parties. It has thus passed beyond the jurisdiction of this Department. It is hoped that the law will be found adequate to reach this class of offenders.

This Department acted with vigor and dispatch when it got evidence of wrongdoing on the part of its own officials, but we have no evidence of disciplinary or preventive action at the traders' end of the line, where gamblers interested neither in production nor consumption disturb values to the injury of both, and make loud outcry when creatures of their own kind corrupt officials to betray confidence for the love of money. The responsibility for this "leak" is shared by everyone who, to get money without work, gambles in farm products. When this form of industry ceases these parasites who tempt Department officials will have to work for their bread.

METHOD OF PREPARING REPORTS.

For the purpose of checking up the results of the several sources of information and reducing the possibility of error to a minimum, the final results are made up by a crop-reporting board composed of the

Chief Statistician or Chief of the Bureau of Statistics, as chairman, and four individual members, selected from statisticians and officials in the Bureau and members of the special field service called to Washington on report days for that purpose. Thus the plan is to select this board of four members each report day from an available corps of six or eight men well trained and thoroughly informed as to crop conditions and as to the relative value and correctness of the reports from the different corps of correspondents. This board, with several expert computers, meets on report days in the office of the Statistician under the personal supervision of the Secretary or the Assistant Secretary.

After the assembling of the board all reports by States from the several distinct corps of correspondents are brought together in convenient form in parallel columns on final tabulation slips, and the board is thus provided with several separate estimates covering the same territory and the same crops, made by the respective corps of correspondents, each reporting for a territory with which he is thoroughly familiar. There are also prepared for the board abstracts of the reports on each crop by States from the weekly weather-crop bulletins of the Weather Bureau, issued during the month. With all these data before them each individual member of the board computes separately his own estimate of each crop by States. These reports are then compared and discussed by the board under the supervision of the chairman, and the final figures by States are decided upon. It is interesting to remark how often the reports from the different corps of correspondents are very nearly identical and how often the final figures arrived at by the individual members of the board agree with each other. These State estimates, which are in percentages, are then multiplied into the acreages for their respective States. The sum of these products is divided by the sum of the acreages, giving the percentage for the entire crop for the United States.

METHOD OF ISSUING REPORTS.

Reports in relation to cotton thus prepared by the crop-reporting board are issued on the 3d of each month during the growing season, and reports relating to the principal farm crops and live stock are prepared and made public on the 10th day of each month. In order that the information contained in these reports may be made available simultaneously throughout the entire United States, and that one part of the country may not have the advantage over another, they are simultaneously handed, at a given hour—as at 12 o'clock noon or 4 o'clock p. m.—on report days, to all applicants and to the Western Union Telegraph Company and the Postal Telegraph Cable Company for transmission to the exchanges and to the press. A mimeograph statement also containing such estimates of condition or actual production, together with the corresponding estimates of former years, for comparative purposes, is prepared and sent to a mailing list of exchanges, newspaper publications, and individuals. The same afternoon printed cards containing the essential facts concerning the most important crops of the report are mailed to the 77,000 post-offices throughout the United States for public display, thus placing the most available information within the farmers' immediate reach.

Promptly after the issuing of the report it, together with other statistical information of value to the farmer and the country at large,

is published in the "Crop Reporter," an eight-page publication of the Bureau of Statistics, under the authority of the Secretary of Agriculture. An edition of over 100,000 of this Reporter is distributed to the correspondents and other interested parties throughout the United States each month.

CHANGE IN METHODS.

A very great improvement has been made in the special field service by districting the United States and assigning each of the field agents to a definite group of States, which they thoroughly travel over and report on each month. The cotton-producing States have thus been redistricted and the service augmented and perfected there by the appointment of two new agents, men widely recognized as having a thorough knowledge of conditions and of the highest ability and integrity. A special agent has also been appointed for the collection of statistics of tobacco and has entered upon his duties of supplementing the reports from the Bureau correspondents by actual observation in the field. The work of the State statistical agents also is being improved.

Working in harmony and cooperation with the Census Bureau of the Department of Commerce and Labor, the compilation of statistics of the commercial cotton crop has been transferred to the Census Office.

The resignation of Mr. John Hyde as Statistician was accepted, and pending the permanent appointment of a successor to that important office Assistant Secretary Hays was directed to take charge of the Bureau.

FOREIGN MARKETS.

Required by law to collect and disseminate information concerning the exporting of the surplus of farm and forest above the requirements of domestic consumption, and concerning the preparation of such products to meet the special requirements of the various foreign markets, the Division of Foreign Markets of this Bureau has been of much service to the producers and the handlers of the agricultural surplus of this country.

DETAILS OF EXPORTS AND IMPORTS.

The base of the work done is necessarily the assembling and suitable treatment of the statistics of the foreign trade of this country in the products of farm and forest, and this work has been done in the most comprehensive way and with all available detail.

During the past eight years special examination has been given to certain classes of exports. The increasing restrictions of importing countries against the admittance of packing-house products and live meat animals have impelled cattle growing and slaughtering interests to request the aid of this Division; and in partial compliance with this request a complete statement has been prepared to show the extent and directions of this export trade during the last fifteen years.

So many inquiries have been received concerning various features of the exports of agricultural products during a long period of years that a report has been prepared and published covering the exports as far back as 1851.

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Closely related to the disposal of the agricultural surplus is the subject of agricultural imports, and all necessary consideration has been given to this subject, besides utilizing current information. A compilation has been completed covering the last half century of these imports.

Within the last three years more particular attention has been given to the trade of the United States proper with its noncontiguous possessions, in the products of farm and forest.

BALANCE OF TRADE.

A new feature of the examination of statistics of exports and imports of agricultural products is the presentation of the foreign balance of trade in these products for a long series of years. This had not been done by any public office or private individual, and the importance of the matter at once appeared when it was discovered that the great balances of trade in favor of this country have been mostly, if not entirely, because of the products of the farm, which have often been called upon to offset adverse balances in manufactures.

FOREST PRODUCTS.

Particular attention was devoted three years ago to the foreign trade of this country in forest products, and this subject has been one in which current information has since been especially utilized. Statistics in detail of the entire foreign trade in forest products, including both exports and imports, have been compiled for a period of half a century.

EXAMINATION OF COMPETING COUNTRIES.

One of the most useful lines of investigation in behalf of exporters has been an examination of the conditions found in countries which have a surplus in certain agricultural products which meet those of this country in common markets.

General agricultural and industrial conditions have been the subjects of inquiry with regard to Norway, Sweden, Denmark, Spain, Scandinavia, Porto Rico, and the Philippine Islands during the past eight years.

A somewhat allied and more useful and important work has been undertaken with the object of ascertaining in detail the quantities and values of all the agricultural imports of the countries which receive a large share of such imports from the United States, as, for instance, the United Kingdom, Germany, and the Netherlands.

WHEAT AS A WORLD PROBLEM.

Besides such investigations as the foregoing of general trade competition in certain markets, special investigations have been conducted concerning particular products. Wheat is one of these. A special agent of the Department spent over a year in Argentina collecting information concerning the production and marketing of wheat, among other subjects of inquiry.

Wheat again has afforded a special study of its production and prospects in Russia; and, as an important part of the cereal problem of

the world, compendious facts concerning the production of cereals in principal European countries have undergone suitable assimilation for public uses.

Sugar is another product of international concern, and information covering the more important economic features of both beet and cane sugar production has received a clear and ample, although compact, presentation in a bulletin prepared in this Division.

PROBLEMS OF COTTON COMPETITION.

Within very recent years no agricultural product has given to the world as great a problem as cotton, and on this account cotton production, actual and potential, in all of the countries where such production is possible, has received a searching examination. The inquiries made with regard to prospective cotton-growing competition have not so far discovered that it has any reasonable immediate prospects, but rather indicates that if such competition is to arise it will be in consequence of years of effort and development. Besides this, it appears that nearly all regions where new production is attempted for commercial purposes produce a cotton like the Egyptian.

DAIRY PRODUCTS.

The low position occupied by the dairy products of this country in principal European markets has excited comment, and the weakness of their representation in foreign trade statistics has led to a special examination of this subject by an agent who has spent several years in England.

PACKING-HOUSE EXPORTS.

In connection with other work done in the interests of cattle growers and meat packers, particular attention has recently been given to all of the principal countries of the world which have a surplus of these products of the farm or ranch for export.

The principal countries of Europe that import packing-house products have afforded a field for a full investigation concerning the kinds, quantities, and values of such products as enter these countries, together with sources of such imports among the various exporting countries of the world.

TARIFF LIMITATIONS.

In every consideration of an export problem it may be and often is essential that the foreign tariff shall be ascertained and made understandable to the public. Work of this sort has been carried on during the past few years upon a large scale and has embraced the translation and elucidation of all the tariffs of the world governing the importation of packing-house products, of grain and grain products, and of fruits and nuts. A more particular study has been given to packing-house products than to any other.

TRANSPORTATION OF EXPORTS.

Transportation is a prominent subject with which the attention of this Division has been occupied within half a dozen years. The object is to provide the public with useful information concerning the routes

over which the surplus products of the farm go to ports for transportation by water to foreign markets; to explain the methods by which shipments are made; to make known the equipment of the various ports for handling export business; to ascertain and make known the rates charged by railroads for moving freight of this sort; and also to ascertain for the service of exporters what lines of steamships are in regular operation, to what ports they carry freight, and what the charges are for various descriptions of farm products.

RESIDENT LONDON AGENT.

This Department maintains a special agent in London for the purpose of being in closer touch with Old World markets and information, and has done so for the past four years. Besides reporting the crop news of other countries he is engaged from time to time upon special inquiries which are of practical concern to producers and exporters in this country.

GROWING SPECIAL SERVICES.

Along with numerous special lines of work carried on and developed within the Bureau has grown a correspondence with persons in all parts of this country who are in pursuit of special information, and in this way a public service has developed which has assumed proportions of considerable size and of increasing utility.

THE LIBRARY.

For the advancement of work in the Department all important publications relating to agriculture and to the sciences upon which it is based are necessary. General treatises, technical monographs, and new scientific periodicals must be available as laboratory tools for the up-to-date investigators in agricultural science. Over 4,000 such books and pamphlets, including publications of scientific societies, have been added to the Department library during the past year. This growth has been steadily maintained for the past ten years, resulting in a collection of works relative to agriculture, agricultural education and research, as well as the kindred sciences not elsewhere to be found in the country. The collections of works relating to special sciences such as economic entomology, zoology, veterinary science, and botany are of exceptional excellence, both as to size and the number of valuable books of early and late dates.

To facilitate the use of this valuable material, card catalogues, reference lists, and bulletins are maintained and kept as nearly up-to-date as possible.

The present quarters are inadequate for housing this collection of 87,000 books and pamphlets and insufficient in the accommodations for readers and the staff in charge of these books. In addition to space for this valuable possession of the Department, the protection of a fireproof building is most urgent. Such protection, however, will soon be provided by the new Department building.

The resources of the Library are not only made available to scientists at a distance through the system of interlibrary loans, whenever it is possible to do so without interference with the work of the Department, but information is also constantly forwarded in response

to letters from all parts of the country. The reference work of the Library has more than doubled in this direction during the past two years as the facilities for meeting the demands have increased.

The publication of a quarterly bulletin of accessions, which is a representative list of current agricultural literature, and of the index cards to the Department publications has been continued. The latter publication, numbering upward of five thousand cards, is of especial value to agricultural colleges, experiment stations, public libraries, and libraries of institutions receiving the Department publications. These cards furnish a permanent index which can be incorporated with the public card catalogue of any library.

The wide distribution of our publications, especially to institutions and scientific societies in this country and abroad and to foreign governments, has resulted in the receipt of a very large number of transactions, periodicals, and foreign documents, which have added much valuable material to the files of periodicals and other serials in the Library. India, Japan, Australia, and Africa, together with other less remote countries, have generously contributed reports of their work in agriculture in exchange for the printed results of work done by the Department. The foreign mailing lists of the Department being in charge of the Librarian, a system of exchanges is thus maintained which is of great benefit to the Library.

OFFICE OF PUBLIC ROADS.

Probably no field of work is of greater interest to the public at large than the improvement of our highways. The Office of Public Roads, as now constituted, represents a distinct stage in the development of the work undertaken by the Federal Government in 1893 by the establishment of the Office of Road Inquiry. At the time of the establishment of the Office, the lack of a knowledge of existing conditions was a serious hindrance to an intelligent application of any plan for road improvement. The name originally chosen for the Office was suggestive of the purpose of Congress, which was to inquire into systems of road management throughout the United States, and into methods of road making, and to disseminate information as to the results of such inquiries.

The most important result which has been attained up to this time, whether produced by influence in or outside of the Office of Public Road Inquiries, is that the people in all parts of the country are now interested in the subject of road improvement, and are seeking such information as will enable them to carry on the work along intelligent lines. It was found, therefore, that the collection of information must of necessity become only one feature of the work of the Office, and that facilities must be provided for answering as well as awakening inquiries. At the same time the necessity for demonstrating scientific and economical methods of road construction instead of mere agitation has been clearly established.

EXPERT ADVICE AND OBJECT-LESSON ROAD WORK.

The work of the Office is primarily educational in character. Its province is to detail engineers and experts to give information and advice. Whenever there is any question as to what road material is

best suited for the local conditions, samples of all the available materials may be sent to the laboratory of the Office, where tests will be made to determine the selection of the best material. In the majority of cases the detail of an engineer or expert to make a preliminary investigation and give advice is all that is required. There are, however, communities where it has been found advisable to supplement advice by a practical demonstration of effective road building.

OBJECT-LESSON ROADS.

To meet this need the object-lesson method was adopted on the following plan: A section of road is selected for improvement, and after the proper surveys and estimates have been made by an engineer of the Office, expert foremen and machinery operators are sent out in charge of modern road-building machinery, and the local officials are taught by actual demonstration every step in the proper construction of a road. Absolutely no expense is incurred by the Federal Government in this work except for the salaries and expenses of the Government employees, the local communities being required to furnish the right of way, all common labor, teams, materials, etc., used in the work.

The total number of experimental and object-lesson roads built under the direction of the Office since its organization is 96, with a total length of about 39 miles. The roads were built in 28 States, the materials used in construction being shells, gravel, brick, oil, tar, sand-clay, marl, stone, burned clay, slag, and steel track.

Four complete road-building outfits were placed in the field at the beginning of the past fiscal year, and their work has continued without interruption. Twenty-one sections of road have been built during the year in nine States, the total length being a little over 9 miles. In the construction of these roads a variety of materials was used, such as stone, shale, burnt clay, sand-clay, shells, gravel, and marl. The detailed reports submitted by the engineers in charge of work show a maximum cost of 98 cents and an average cost of 55 cents per square yard for macadam roads, while the average cost of sand-clay roads is shown to be 9½ cents. The only burnt clay road constructed was built at a cost of 20 cents per square yard.

In the work done under Government direction there was of necessity a great variation in cost on account of the difference in cost of labor and teaming, amount of grading required, length of haul, and general efficiency of labor.

Since the passage of the act of Congress approved March 3, 1905, creating the Office of Public Roads, steps have been taken to place the field work on a more systematic and businesslike basis than heretofore. This has been to some extent accomplished by increasing the force of engineers and experts and decreasing the number of men detailed as public speakers and lecturers.

A circular of instruction defining object-lesson road work and expert advice within the meaning of the act of Congress, and setting forth the terms under which this Office is prepared to grant assistance is sent out in answer to inquiries on the subject. A blank form of application for expert advice and assistance has been prepared, which is required in every instance to be filled out and signed by the local authorities.

The construction work is at present under the management of trained engineers, who are assisted by experts qualified to operate all road-building machinery. When an object-lesson or experimental road is to be built, complete surveys, plans, specifications, and estimates are prepared and the fullest preliminary information is obtained.

As far as practicable itineraries are made up for each party in the field, covering a considerable period of time, in order that the greatest amount of work may be accomplished with the least expenditure of time and money. The work is planned so that it may be carried on in the North in summer and in the South in winter, thus avoiding interruption as much as possible.

There appears to be a growing need for the construction and maintenance of roads in the forest reserves. In view of the fact that the Office is maintaining a gradually increasing corps of competent highway engineers and experts, it would seem to be a wise arrangement to utilize the services of these men, wherever practicable, in the construction and maintenance of roads in the forest reserves and other areas which are now or which may hereafter come under Government control.

Heretofore machinery has been borrowed from the manufacturers who have been willing to lend it for the construction of the object-lesson roads. Transportation for men and machinery has usually been secured free of charge from the railroad companies, who have generally shown themselves ready to cooperate on the ground that improved highways directly benefit them. The practice of borrowing machinery and of depending upon free transportation is not, however, the best policy. Gratuitous assistance inevitably tends to hamper that freedom of action on the part of the beneficiary which is essential to the proper performance of the work intrusted to public officials. A plan for leasing machinery at a certain per cent per annum of the list price is being favorably considered, and, if the request for an additional appropriation to make this arrangement possible is granted, it is probable that ten outfits of machinery will be secured and placed in the field. It has been ascertained that this plan is perfectly feasible, and that the machinery can be secured at a fair and reasonable rental. Should the recommendation in regard to an appropriation to cover freight charges meet with approval the old practice of free transportation will be abolished.

EXPERIMENTAL FIELD WORK.

There are vast areas in the country in which stone is not available for road making, and in only a few localities has it been found practicable to overcome the difficulty, on account of the cost of transportation. In such cases the problem is how to obtain a suitable substitute. In some sections of the South roads have been built of mixtures of sand and clay. These roads have generally proved satisfactory, and the efforts of the Office have been directed toward originating special methods for putting such materials to use.

In the great Mississippi Delta the use of burned clay or gumbo has been introduced, under the direction of the Office, with what would seem to be marked success. This is shown by the results obtained on an experimental burned-clay road constructed at Clarksdale, Miss. Previous to the construction of this road experiments had been made

in the laboratory of the Office to determine the best method of burning the clay. This experiment may possibly prove of value to other parts of the country, for instance, in many of the prairie States, in which no other form of road-building material is available. The report from the South on this special form of construction has been most encouraging, one county alone having appropriated $25,000 to be expended principally in this way in the immediate future. Roads of this nature are said to be more economical, efficient, and lasting than gravel roads which have been constructed in the same section.

In addition to the study of the various methods of construction and their application to those large sections of the country which at present enjoy few if any improved roads, considerable attention has been given to problems in the maintenance of roads. These have particularly to do with the suppression of dust, which has already become in some localities such a nuisance as to warrant considerable expenditure for its cessation. This is a question that has already received the attention of the French Government road engineers, as well as those in England and elsewhere, for the past seven or eight years. It is now occupying the attention of highway engineers in this country.

A treatment which will retain the dust on the surface of a macadam or gravel road is of special value at present, owing to the great damage done to such roads by motor-car traffic, which has the effect of loosening the dust to such an extent as to seriously damage the road.

Extensive experiments for laying dust by the application of oil and coal tar on macadam and earth road surfaces have been conducted by this Office during the past year at Jackson, Tenn., and it is hoped that the data and information to be obtained from these experiments will be of great interest and value. In this connection it might be mentioned that perhaps more inquiries are received concerning the use of oil and tar than on any other phase of the work of this Office. At present there exist little or no exact data on this subject, but it is believed that the experiments referred to will in a great measure answer many of the questions that are now in doubt.

There are at present a number of patented solutions which are recommended to lay the dust on roads more effectively and economically than water sprinkling. It is expected that investigations will be carried on in the laboratory of this Office to ascertain the relative effect of various chemicals which may be used in sprinkling streets and roads.

INSTRUCTION IN HIGHWAY ENGINEERING.

In order to secure engineers having the necessary technical training as a basis, and to supplement such training by special work in highway engineering under the direction of the Office, the plan has been adopted of appointing graduates of reputable engineering colleges to the position of civil engineer student in the Office of Public Roads. These young men are required to pass rigid competitive examinations before entering the service and receive practical and scientific instruction and work for the period of one year, this being in the nature of a graduate course in highway engineering. At the end of that time they are given a certificate in the nature of a diploma, and may be retained in the service without further examination.

The work of these students includes personal inspection and reports in detail of the methods of construction carried on by different State

highway commissions in the States where such work has been systematized and put upon a practical basis. They are also required to make surveys and estimates of the actual cost of building roads under various local conditions. Thorough training in methods of testing the various qualities of road materials is acquired by actual work in the laboratory, so that the value of the different physical properties of the materials may be made clear to them. The work of these engineer students is of great assistance to the Office, in addition to being of much practical value to the public at large.

It is of the utmost importance that the great sums of money appropriated for road improvement throughout the country should be expended wisely, under the direction of properly qualified men. At the present time the number of trained highway engineers is entirely inadequate to meet the demand. It will be of inestimable value to the public if the Office can provide even a few such men each year.

Instruction in highway engineering in schools and colleges throughout the country should receive greater attention at the present time, owing to the rapid development of road building. The Office, so far as its limited facilities permit, will cooperate with the various educational institutions in placing this branch of education on an adequate basis and in inaugurating highway work.

TESTING OF MATERIALS AND SPECIAL INVESTIGATIONS.

One very important feature of the development of the work of the Office has been the testing of materials available for roads in different parts of the country and the investigation of special qualities which are necessary if the most successful results are to be obtained. A large number of tests have been made on all the different kinds of materials which are in use in the construction of highways, and in addition to these routine tests a number of important and valuable investigations have been carried on. By far the greater number of tests have been made for the benefit of State and municipal authorities who have evinced a desire to obtain accurate data to enable them to make a careful and wise selection of the best material at hand. The best indication of the importance of this work is shown by the fact that many of the State governments are establishing laboratories and conducting work along the same general lines that have been followed in the laboratory here.

The equipment of machinery necessary for testing road materials is also available for testing other materials of construction relating to agriculture, and thus duplication of equipment is avoided by extending the scope of the work of the Division of Tests. It has been possible to undertake several investigations which bear directly upon problems that the farmers of the country have to face.

For some time past numerous complaints from a variety of sources have reached the Department concerning the inferior lasting quality of the steel-wire fencing offered in the market at the present time. Preliminary inquiry showed that these claims were well founded, and a thorough investigation was ordered. Enough has already been accomplished to show that the farmers will derive great benefit from this work.

The interest of manufacturers has been aroused to the extreme importance of this matter, and measures are already being taken in

many of the leading manufactories to bring about an improvement in the conditions complained of. When it is considered that much of the wire which was produced thirty years ago is still in good condition, whereas the life of wire put on the market in more recent years is often not longer than two to seven years, the money saving to the farmers of the country that will be brought about by the improvement in present conditions becomes apparent.

The fact that in many parts of the country it is difficult to procure wood for fence posts, added to the fact that wooden posts rapidly decay, has stimulated the desire to present the farmers with simple information and directions that will enable them to make use of reinforced concrete. Reinforced-concrete fence posts of various types have been made in the laboratories and tested.

One of the most important qualities possessed by rocks which render them useful for macadam-road building is that of binding power. A study of this important quality has been one of the principal subjects of investigation by the Division of Tests, and several valuable bulletins have been published setting forth the results obtained. In the course of this work it was observed that when some rocks are ground to very fine powders they undergo certain decompositions, owing to the action of water. In view of the fact that many of our large rock deposits are rich in potash, and in view of the extent to which these decompositions are found to take place, it becomes apparent that if the rocks are subjected to a process of fine grinding it is possible that they may be directly available as fertilizers.

The importance of this subject of investigation can not be overestimated, when it is considered that no original source of potash exists in this country to-day and that we are entirely dependent upon foreign sources of supply for all the potash used annually by our farmers and growers. The further investigation of the possible source of supply will be vigorously pushed in the various bureaus of the Department which are especially equipped for carrying on work of this nature. Under the stimulus of the cement industry, which has grown to enormous proportions in this country, the development of machinery for grinding rock to fine powders has made rapid strides within the past few years, and it is now possible to consider the feasibility, from an economic standpoint, of grinding material which a few years ago would have been out of the question.

In view of the growing importance of the cement industry to-day it is necessary to prosecute studies and inquiries into the actual constituents and character of Portland cement, and to this end an agent of the Office was assigned to work on this subject.

It is proposed during the next fiscal year to carry out investigations along the same general lines, adding from time to time other problems of a similar nature in so far as time and equipment will permit.

COLLECTION OF INFORMATION.

While it is known in a general way that some parts of the country have progressed much further than others in the matter of road improvement, there is little available information regarding what has been accomplished in the various States and counties. If comprehensive statistics were available it would be shown that large sums of money are annually wasted in some sections, while in others surpris-

ingly satisfactory results are obtained at a moderate cost. The Office is now collecting information from every county in the United States in regard to the mileage of improved and unimproved roads, the amount of cash tax, bonds issued, and other information of a similar nature. No more telling argument for reform in wasteful methods can be adduced than to bring home to every county just what results they are obtaining as compared with the results obtained by other counties at a similar cost. This information, which is now being compiled, will be published for each State as soon as completed.

CONVENTIONS.

Government participation in road conventions and the organization of road associations has been considerably curtailed during the past year. Such participation does not seem to be justified when the sole object of the meeting is agitation for the purpose of influencing legislation. Aside from the propriety of the case the results achieved through speeches by Government employees at popular gatherings of this character can scarcely be considered as having a marked influence upon the progress of road improvement in the United States.

There is, however, a field of real usefulness to be reached by means of speakers and lecturers of the Office. Road organizations serve a useful purpose in arousing the people to a realization of the need for better roads. The problem that is most serious to rural communities, and one which it should be the province of specially equipped employees to explain at meetings of local officers and taxpayers, is what they need, how to go about getting it, and what their roads will cost. These speakers should be so well equipped that they can give definite and concise information, on which the local committees may act with safety.

Another branch of this work capable of beneficial results is a cooperative system of lectures in engineering schools throughout the country. As already stated, the demand for skilled highway engineers is already in excess of the supply and the educational institutions of the country should take prompt and adequate steps to meet the situation. Aside from the engineering features, there are many economic questions involved that should be brought out in lectures to students who intend to devote their lives to highway work.

Much of the work embraced in the scope of the Office is of a scientific and technical nature and involves original thought and investigation. Papers should be prepared and read at the meetings of scientific bodies, and properly qualified members of the Office should keep in touch with organizations having under consideration matters bearing in any way upon the purposes for which the Office was established.

OFFICE OF EXPERIMENT STATIONS.

RELATIONS WITH AGRICULTURAL EXPERIMENT STATIONS.

The work of the Office of Experiment Stations has greatly increased during the past eight years, partly by the extension of its business along lines previously established and partly by the addition of new functions. The Office was established to be a clearing house for the agricultural experiment stations organized under the act of Congress of 1887, and as such it has accomplished much valuable service. This

Office is charged with the supervision of the Federal funds granted to the experiment stations and issues a considerable number of publications based on their work. The policy has been to make the supervision of these funds more strict and to insist on their application to agricultural research. The result is that the stations have been greatly strengthened as research departments of the agricultural colleges, and their experimental work has been so successful as to win the support of a very large constituency of intelligent farmers. The States have thus been led to supplement the funds granted to the stations by Congress, until now the annual resources of the stations from sources within the States are equal to those derived from the National Treasury. While many forces have contributed to this end, the influence of the Department is generally acknowledged as an important factor in determining the success and prosperity of the stations and in making our experiment-station system the strongest and most efficient in the world.

It is fitting in discussing the relations of the Department with the stations to call attention to the great influence the latter have had in bringing home to the people the results accomplished. Not only have the stations been a vital factor in making the Department's work more effective, but they have by their own investigations lifted American agriculture to a higher plane.

The Department is cooperating in many ways with practically all of the stations, and as time goes on this work is bound to increase. The stations have now reached a critical point in their development, and they need and will receive all the assistance the Department can give them. In the increasing demand for more light on agricultural practices and the growing interest in rural life generally, the stations must have the means for meeting these demands. It is hoped that Congress will recognize this need, as it is already being recognized by some of the States themselves. There is no direction in which public moneys can be appropriated that will bring more certain and lasting returns than in helping the State experiment stations to do more research work.

The close relations which the Department has held with the stations in recent years has naturally led to a great increase in the number and extent of the enterprises in which the Department and stations have cooperated. By this means the range and effectiveness of many agricultural investigations have been enlarged, and it has been possible to bring the Department's work into vital touch with agricultural industries and agricultural people.

PROMOTION OF AGRICULTURAL EDUCATION.

The period covered in this review has witnessed very great activity in the development of agricultural education by the reduction to pedagogical form of the great mass of educational material accumulated by this Department, the experiment stations, and similar agencies in many countries; by the enlargement and better organization of agricultural faculties in our colleges; by the providing of more adequate buildings, apparatus, illustrative material, and other equipment for agricultural instruction, and by the extension of agricultural courses to the lower schools.

The Department has been active in promoting this educational development in various ways, and the Office of Experiment Stations,

through its intimate relations with the agricultural colleges, has naturally taken a leading part in this work.

Since the permanent success of agriculture depends on the intelligence and technical knowledge of the farmers, the Department can engage in no more important work than to aid in arousing agricultural people to a keen sense of the importance of establishing in this country a system of public education which will make men and women not only intelligent citizens but also efficient and successful workers in agriculture and the other industries which must ever engage the attention of the great mass of the population. This Department and the experiment stations are largely engaged in gathering the materials which will constitute the future of education in agriculture, and the permanent impression which their work will make on agricultural practice will be largely determined by their success in incorporating the results which they obtain in courses of instruction to be given the youth in agricultural colleges and schools. The Office of Experiment Stations has been encouraged to ally itself as closely as possible with the movement for the extension of agricultural education among the colleges and in the public schools, and the Department will this year recommend to Congress that provision be made for a more active propaganda by this Office in the interests of agricultural education, for it is certain that active work in this direction will produce far-reaching results in the near future.

AID TO FARMERS' INSTITUTES.

Recent years have also witnessed the development of a great system of popular agricultural education for the adult farmer through the farmers' institutes which are now held throughout the country and annually attended by about a million men and women engaged in agricultural pursuits. With the growth of the research work of this Department and the experiment stations it has become very evident that publications alone would not meet the demand for information regarding improved methods of agriculture and the ways in which the results of scientific investigation may be applied to agricultural practice. The absence of agricultural instruction in the schools and the coming on to the farms of millions of people from foreign lands, together with the widespread interest in the results of agricultural research, have made it necessary that means be devised for giving agricultural people instruction by word of mouth which will enable them to understand and utilize the information so largely given out in the publications of this Department and the stations.

For this purpose the farmers' institutes established under public authority in the States and Territories furnish an agency of great usefulness. It has therefore seemed highly desirable that this Department should ally itself closely with the farmers' institutes, and make them efficient instruments for the wide diffusion of the knowledge gained by the Department and other agencies for agricultural research. With this end in view a farmers' institute specialist was appointed two years ago in the Office of Experiment Stations, and efforts have been made to place at the disposal of the institute lecturers the information gained by the Department in many lines.

ESTABLISHMENT AND PROGRESS OF EXPERIMENT STATIONS IN ALASKA, HAWAII, AND PORTO RICO.

Under various acts of Congress provision was made for agricultural experiment stations in Alaska, Hawaii, and Porto Rico, and the stations were established in Alaska in 1898 and in Hawaii and Porto Rico in 1901. Their administrative control was placed in the Office of Experiment Stations, and a Division of Insular Stations was created.

The headquarters of the Alaska stations were established at Sitka, and branch stations were undertaken at Kenai, Copper Center, and Rampart. In Alaska the first problem was the introduction of agriculture. With a few exceptions about some of the larger villages, little had been attempted in the way of gardening, and nothing done on an extensive scale. Much pioneer work in the way of clearing, fencing, building, etc., was necessary at all these places, but attention was given from the first to the introduction of varieties of economic plants that were thought promising for this country. When tried and found adapted to the prevailing conditions they were distributed as far as possible, and the settlers urged to take up their cultivation. For a time the principal investigations were with garden vegetables, and it has been demonstrated that the growing of hardy vegetables is possible over a great portion of Alaska as far north as the Arctic Circle. This has made possible a wide extension of gardening, and many villages owe their present supply of fresh vegetables to the demonstration of the experiment stations.

Cereal growing has also been taken up and found practicable away from the coast, rye, barley, and oats having matured every year at the Rampart Station, although situated at 65° 30′ north latitude. The climatic conditions at Sitka not warranting extensive experiments with cereals, horticultural crops of various kinds are being investigated, and nurseries of hardy fruits, berries, etc., have been established. In addition to introductions, experiments in plant breeding with native fruits are being carried on with promise of success. Soil studies made over large tracts have shown that the seemingly rich soils are peaty and often quite acid. Methods of treatment for correcting the faulty conditions have been found, and the station's results are being widely adopted. Experiments in animal husbandry and dairying have been begun and will be developed as the facilities of the stations will admit.

In Hawaii the station was located adjoining Honolulu, on a tract of land set aside for the purpose by the Territorial authorities. The work in Hawaii has been along the line of the development of agricultural industries, to supplement sugar-cane growing and to secure a greater diversification of crops. The station's experiments with tobacco, although only carried on for the past two years, seem to indicate that it is entirely feasible to grow a type of cigar tobacco but little, if any, inferior to the average product of Cuba. Previous experiments with tobacco had failed, but with attention to varieties, soils, curing, and fermentation a product was secured that was given high rank by experts. Successful efforts to introduce forage plants for the stock ranges have been noted in a number of instances, and a prominent stockman says the success along this one line is worth many times over what the station has cost. Through the station, bananas from Central America have been introduced to supplant the varieties in cultivation for markets of California, Oregon, Washington, etc. The

local varieties do not bear shipping well and the Central American varieties are superior in this respect. An effort is being made to develop the growing of citrus fruits for local use, the supply now coming almost wholly from California. Investigations are being made of fungous and insect pests, soils, etc., and many matters of great importance have been discovered and the results given to the public.

The Porto Rico Station was first located on a tract of leased land near Rio Piedras, but after a year it was permanently established at Mayaguez, where a plantation of about 240 acres was furnished by the insular authorities. One of the chief problems in Porto Rico has been the introduction of improved methods of agricultural practice. To supply information along this line experiments have been inaugurated with nearly all agricultural and horticultural crops grown on the island, and also with others believed to be adapted to the conditions. It has been possible to suggest methods whereby increased production with several crops can be secured with but little more labor and expense than that usually given. Insect pests have been studied and means found for combating a number of the more destructive ones. Experiments with coffee have been in progress ever since the station was established, and trees under investigation yielded double the crop obtained from others in the same plantation. The means by which this result was obtained were pruning, cultivation, and fertilizing, and they may be readily followed by any grower. A large collection of economic tropical plants has been brought together, permitting a comparison of varieties, testing their adaptability, and making possible plant-breeding work on an extensive scale. Experiments with horses, cattle, and pigs have been begun and will be extended as opportunity offers. Other experiments under way are with leguminous plants for forage and rotation crops, rice growing, citrus and other fruits, vegetables, etc. The value of tile drainage has been shown by a demonstration on part of the station farm. This was the first piece of tile drain in Porto Rico, and its efficiency is well recognized.

All the insular stations cooperate in various ways with our Bureaus, giving a wider field to the investigations of the Department, while the stations receive the benefit of our more extensive resources. These stations are all becoming centers of information and demonstration in their several localities, and their power for good is already recognized.

PROGRESS IN NUTRITION INVESTIGATIONS.

The nutrition investigations have been conducted on a cooperative plan by which work has been undertaken in nineteen States and three Territories, in which the Department has been associated with experiment stations, agricultural colleges, universities, and other educational institutions, philanthropic associations, hospitals, and institutions for charity and correction. The Department funds have been supplemented in various ways, including the use of laboratories, apparatus, and the time of investigators, as well as by State appropriations and funds derived from other sources.

During the past eight years the work has developed very materially both in scope and in the importance of the results obtained. During this time some 200 dietary studies have been made and not far from 800 experiments in which the digestibility of different foods was deter-

mined with healthy men under normal conditions. Over 70 experiments with the respiration calorimeter have been completed with 9 different subjects covering a period of two hundred and nine days, during which time the total income and outgo of both matter and energy have been measured and studied. Many experiments have also been made regarding the changes which take place when meat, vegetables, and flour and other cereal products are cooked in different ways, and considerable attention has been devoted to the compilation of the results of Department work, as well as that of other investigators.

As the nutrition investigations have developed it has been found in the main desirable to concentrate resources upon several problems which have seemed of special importance and to cooperate with institutions where conditions were particularly favorable.

The experiments which have been carried on in California have demonstrated the fact that both fruits and nuts may furnish a considerable portion of the diet at a reasonable cost.

A large number of studies made at the Maine and Minnesota experiment stations have shown that, with all classes of wheat, white bread furnishes the body with more protein and energy, pound for pound, than whole wheat or Graham flour ground from the same lot of grain, since any deficiency in the composition of the white flour is more than offset by its more thorough digestion. Investigations with cereal breakfast foods have also shown that the different commercial brands differ little in real nutritive value, though they differ widely in cost and quite considerably in method of manufacture. The different kinds of bread have been shown to be wholesome and economical foods, and the same may be said of the standard breakfast foods, the use of different kinds of breads and breakfast foods being an easy way to secure that variety in the diet which is considered important as well as pleasing.

The Tennessee investigations have demonstrated that dried legumes (beans, peas, and cowpeas) are quite thoroughly digested and are economical sources of vegetable protein. The thoroughness with which they are assimilated depends in considerable degree upon the method of preparation, being greatest when the legumes are so thoroughly cooked that they are readily masticated and thoroughly mixed with the digestive juices of the stomach and intestinal tract.

As shown by the investigations at the University of Illinois, the losses which meat sustains when cooked in hot water are greater than when dry heat is used, as in roasting or baking, though in all cases the losses of nutrients are small. Dry heat applied in different ways develops flavor to a greater extent than cooking in hot water. The different kinds and cuts of meat differ somewhat in the thoroughness with which they are digested, as do meats cooked in different ways. However, it may be said that meats as a class are very thoroughly assimilated by the average man under normal conditions.

The experiments carried on at Middletown, Conn., with the aid of the respiration calorimeter have furnished very accurate data regarding the actual energy requirements of the body, the relative energy production at work and at rest, sleeping and waking, and under other conditions; the normal variations in body temperature, effect of varying amounts of carbon dioxid and moisture in the air upon bodily comfort, the relation between food consumption and excretory products, and similar topics; they have also supplied valuable data for the

discussion of problems of ventilation and hygiene. Recently, as a part of this work, very important and useful factors have been deduced with which it is possible to compute the carbon dioxid and energy output of man at rest and performing muscular work of different degrees of severity, and also the energy expended per day by men engaged in any one of the ordinary occupations or trades. When these quantities are known it is possible to form an estimate of the actual food requirements.

ESTABLISHMENT AND DEVELOPMENT OF IRRIGATION AND DRAINAGE INVESTIGATIONS.

In 1897 Congress appropriated $10,000 to enable this Department to investigate irrigation laws and irrigation practice. The present Irrigation and Drainage Investigations, for which $74,200 was appropriated in 1905, is the outgrowth of this initial appropriation. It was the beginning of systematic study by the General Government of the agricultural and legal features of irrigation—the two features which have a controlling influence on the peace and enduring prosperity of irrigated districts.

The need of more definite information on these subjects was shown in the wide discrepancy of view regarding the duty of water as exhibited in court decrees fixing water rights and in the water-right contracts of canal companies, the quantity allowed for the irrigation of an acre of land one year varying all the way from enough to cover it to a depth of 6 inches to enough to cover it to a depth of 500 feet. The value of these measurements of the duty of water has been shown in preventing decrees for excessive amounts of water and the chaos, injustice, and unending litigation which came from decisions and agreements which gave one man more than he could use profitably and another less than his crops required.

These measurements of the quantity of water used in ordinary practice have been followed by more careful experiments to determine the frequency of irrigation and the amount of water which should be applied at each irrigation in order to get the best results. The object of these investigations is to furnish the information needed to establish a proper system of rotation, prevent the injury of land by excessive use of water, and reduce to a minimum the losses from seepage and evaporation.

Accompanying the measurements of the duty of water have been measurements of the losses from seepage and evaporation in canals and ditches. These losses were far greater than had been commonly supposed, amounting in many instances to more than half the water turned in the head-gates.

The determination of seepage losses has been followed by experiments in the lining and puddling of ditches to lessen such losses, which have been an active agency in improving this feature of irrigation practice and increasing the service which streams will render. It has also retarded the extension of the area injured by seepage water and alkali.

An important feature of irrigation development in the United States is that each year thousands of acres of new land have to be cleared of brush, graded, and ditched for the distribution of water. Another

fact is that much of this work is done by settlers to whom the whole subject of irrigation is strange and new. Nothing could have been more wasteful than to leave each of these beginners to find out for himself how to do this work, and the Department has rendered valuable aid by the publication of practical bulletins describing the tools and methods of clearing and grading land, giving the cost of this work, and explaining the methods of applying water suited to different soils, crops, and climates. The information given in these bulletins has been collected in widely separated sections of the country and includes practically every method of applying water to be found in this or any other irrigated country.

The studies of irrigation laws and irrigation institutions have included the collection of facts showing the character and amount of the water rights and the methods of their establishment in the different Western States. Having the facts before them, the people of those States have been able to determine what sort of legislation was required for their improvement, and it has been the policy of the Department to let these facts furnish their own argument, the Department confining itself to the statement of the general principles which should underlie the control and management of public water supplies. It is not possible to speak certainly regarding the influence which these investigations have exerted, but it is known that in the eight years since they were begun there has been a progressive interest in the reform of irrigation statutes and in the laws and customs which determine the relations of irrigators to each other. The facts presented in the official bulletins of this Department have been largely quoted and the laws enacted have been in harmony with the general policy advocated by this Department.

Irrigation and drainage are inseparable. In every irrigated district some lands have to be drained. Without this the soil water rises to the surface and renders the land unproductive from excess of water or alkali. The drainage investigation grew out of need for plans for removing the excess of water coming from seepage and waste on irrigated fields. It has been extended to embrace the entire country, where in many sections drainage is a fundamental necessity if the full productiveness of the soil is to be secured. The drainage problems which have been dealt with have included the preparation of plans and giving expert advice about large projects and the making of studies to determine the feasibility of drainage and the methods to be followed in many parts of the Mississippi Valley.

Experiments are also being made to determine how far drainage can be made to protect hillsides from the destructive effects of erosion. In the whole United States there are about 100,000,000 acres of swamped and overflowed lands which can be reclaimed only through drainage, which will change these from unhealthful and worthless areas into some of the most productive farm lands in the country.

To these two branches of rural engineering there was added last year the study of farm machinery and appliances used in agriculture. The tools and implements used on the American farm cost approximately $100,000,000 a year. The farmer must make this large outlay because it is only through this means that he can offset the scarcity and high price of farm labor; but farm implements are becoming each year more complex and costly and require a greater knowledge of mechanical principles to select and use them. The purpose of this

work is to aid the present generation of farmers in acquiring this knowledge and to aid the agricultural colleges and experiment stations in the preparation of courses of instruction for the more effective equipment of the coming generation.

NEW BUILDINGS FOR THE DEPARTMENT.

The need of better buildings for the Department of Agriculture has long been felt. For the past fourteen or fifteen years attention has been called from time to time to the inadequate structures, especially in so far as relates to laboratory uses. Six years ago systematic effort was undertaken to secure buildings commensurate with the needs of the Department. Preliminary appropriations were made for plans, which were followed eventually by appropriations for the buildings themselves. The Department now has under construction two wings, constituting a part of a series of buildings which, when completed, it is believed will meet the requirements of the work. Every effort has been made to have these buildings constructed with due regard to the important work which the Department is conducting and in recognition of the fact that Washington itself is destined to have a system of public buildings second to none in the world. The present structures, which will cost about $1,500,000, will be completed in two years, and by that time it is hoped that further appropriations will be available for a continuation of the building work inaugurated.

GROWTH OF THE DEPARTMENT.

The history of this Department's growth during the past eight years may be epitomized in the statement that the appropriations for its use have increased from $2,500,000 in 1897 to considerably over $6,000,000 in 1905, and that this increase in appropriations has been accompanied by a much greater increase in the amount of work done. Not only has the work of the Department been vastly augmented, but its scope has been correspondingly broadened and its practical value heightened.

Another interesting evidence of the growth of the Department during the past eight years is afforded by the records of the appointment clerk's office. These show that the total number of persons on the rolls of the Department of Agriculture July 1, 1905, was 5,446. Of this number those rated as scientists and scientific assistants numbered 2,326. On July 1, 1897, the total number of persons on the rolls of the Department was 2,443, of which number those rated as scientists and scientific assistants numbered 925. These figures show an increase in the total force during these eight years of 3,003 persons, while the increase in the number of those rated as scientists and scientific assistants was 1,401.

CONCLUSION.

It has been my gratifying task in the foregoing pages to present to you, and through you to the American people, a pen picture of the American farmer as he is to-day; to make clear the position of the farming industry and its relation to other industries; its wonderful productiveness and its large contributions to the general prosperity the country enjoys.

I have also sought to point out some of the more important work accomplished by the Department, illustrative of the methods by which it seeks to work for the practical benefit of the farmer. The work of this Department is twofold. It must seek to add to the sum of intelligence of the man and to increase the productive capacity of the acre. In this important work it has the hearty cooperation of the State agricultural colleges and experiment stations, all of them working with the Department of Agriculture toward the same great end. The gratifying evidences of well-being in our farming community, the extraordinary progress made in the past few years, and the rapidly enlarging recognition of the true position of the farming industry in the economic life of this country are mainly the result of this continued and combined effort on the part of these agencies to add to the sum of the farmer's knowledge, and must be regarded as the triumph of intelligence in the application of scientific knowledge to the tillage of the soil. This is so obviously true that it would seem superfluous to urge the generous maintenance of the Department in its grand work. Great as has been the work undertaken and accomplished, gratifying as have been the results, as shown in the first few pages of this report, be it remembered that we are still at the threshold of agricultural development, and that the educational work which has led to such grand results has only been extended as yet to a portion of our agricultural population. There is not an intelligent, patriotic citizen in the Union who will not say with his whole heart, "Let the good work go on."

Respectfully submitted.

JAMES WILSON,
Secretary.

WASHINGTON, D. C., *November 22, 1905.*

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U. S. DEPARTMENT OF AGRICULTURE.

Report No. 82.

9th

PROGRESS

OF THE

BEET-SUGAR INDUSTRY

IN

THE UNITED STATES

IN

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U. S. DEPARTMENT OF AGRICULTURE.

Report No. 82.

PROGRESS

OF THE

BEET-SUGAR INDUSTRY

IN

THE UNITED STATES

IN

1905.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1906.

To the Senate and House of Representatives:

I transmit herewith for the information of the Congress a report on the Progress of the Beet-Sugar Industry in the United States in 1905. Your attention is respectfully invited to the accompanying letter of the Secretary of Agriculture, recommending that 10,000 copies of the report be printed for the use of the Department of Agriculture in addition to such number as may be desired for the use of the Senate and House of Representatives.

THEODORE ROOSEVELT.

THE WHITE HOUSE,
April 27, 1906.

LETTER OF TRANSMITTAL.

U. S. DEPARTMENT OF AGRICULTURE,
OFFICE OF THE SECRETARY,
Washington, D. C., April 24, 1906.

MR. PRESIDENT: I have the honor to transmit herewith for your information and that of the Congress of the United States a report entitled "Progress of the Beet-Sugar Industry in the United States during 1905," prepared by Mr. Charles F. Saylor, special agent of this Department. The report also includes a brief account of the "Sugar-beet Investigations conducted by the Bureau of Plant Industry."

In view of the popular interest in the subject of this report, I respectfully recommend that at least 10,000 copies of the report be printed for the use of this Department in addition to the number which Congress may in its wisdom order for the use of the members thereof.

I have the honor to remain, Mr. President, very respectfully,

JAMES WILSON, *Secretary.*

The PRESIDENT,
The White House.

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PROGRESS OF THE BEET-SUGAR INDUSTRY IN THE UNITED STATES IN 1905.

REPORT OF THE SPECIAL AGENT,

CHARLES F. SAYLOR.

LETTER OF SUBMITTAL.

U. S. DEPARTMENT OF AGRICULTURE,
OFFICE OF THE SPECIAL AGENT,
Washington, D. C., April 3, 1905.

SIR: I submit herewith for your inspection and approval the manuscript of my ninth annual report on the Progress of the Beet-Sugar Industry in the United States. It contains a general review of the progress that has been made during the past year (1905), a survey of the prospects for factory building, and a limited amount of miscellaneous information concerning various phases of the industry.

Respectfully,

CHAS. F. SAYLOR,
Special Agent.

Hon. JAMES WILSON,
Secretary of Agriculture.

INTRODUCTION.

In making this, my ninth, annual report on the Progress of the Beet-Sugar Industry in the United States, I wish first to call attention to a few of the more striking features of its present development. In general it may be said that the progress being made is highly satisfactory to all the interests concerned. The pioneer period of the industry—the period of experiment, of investigation, of doubt, of mistakes—appears to have ended, and the period of confidence, of reliable information, of careful advancement along safe lines is well begun.

ARID-LAND RECLAMATION AND DEVELOPMENT OF THE WEST.

A paramount fact in the development of our great West to-day is the reclamation of arid lands through irrigation. This is becoming the all-absorbing question in most of the area west of the 100th meridian. The great popular interest in this subject has been inspired largely by the National scheme of reclamation by the use of funds derived from the sale of public lands. The cost of the undertaking is

gigantic, but no less so than the industrial and social development which will speedily follow. The importance of the changes which will take place can hardly be estimated. Regions which are now barren and untenanted will be settled, towns and cities will be built and equipped with all of the modern means of communication—railroads, trolley lines, telephone and telegraph lines, and rural free delivery of mails—schools and churches will be built, and the population of these new communities will enjoy all the benefits and conveniences of modern life. To accomplish all this in a decade seems like the work of magic. One can hardly keep track of this evolution of the West. It appears like doing in a few years what has hitherto been considered the work of a century. Among the industries which will play the most important part in working this modern miracle is the beet-sugar industry. Some of these Government ditches are nearing completion. There are many under way, and wherever water flows or is planned to flow on the land through these systems can be found plans and prospects for establishing the beet-sugar industry. To be convinced of this one has but to travel over Colorado and Idaho or elsewhere among the valleys of the western mountains.

The installation of a sugar factory is always accompanied by the introduction of the most modern and scientific methods of farming applied to beet culture, and incidentally to other branches of farm industry. Intensive farming is taking the place of cattle and sheep grazing.

With the advent of more dense populations comes the demand for modern appliances and equipment. This leads to harnessing the power of the descending mountain currents to produce light, heat, and power. Through the ditches and over the wires come these modern agents of helpfulness to civilized man's industry. For ages the energy of these mountain streams has gone to waste. To the aborigine and the early white settler the shining whiteness of the snow caps in the distance meant only the decoration of the landscape. To the modern inhabitant it means a potency far reaching in the economy of human affairs. From these melting snows come streams leaping down to the valleys pregnant with energy to be applied by man in digging the ore from the mountains and extracting the metal from it, in speeding the wheels of transportation, in producing light and heat for the home and business house, and in furnishing power for use in manufacturing. To utilize this energy there must be population. Population must have a supporting agricultural industry. The establishment of beet-sugar factories not only makes it possible to utilize these great natural forces, but fosters one of the greatest and most profitable forms of agriculture.

SUGAR REFINERS BECOMING MANUFACTURERS.

In this introductory survey I must not fail to recount the improvement in the business status of the sugar traffic. It is well known that the forces involved in the conduct of a specific business tend to produce currents confined to well-defined channels. This is necessarily so, or all business would be erratic, panicky, and easily disturbed. These currents do not tend to deviation unless some unusually potent influence swerves them. A decade ago the beet-sugar industry received a great impetus. The sugar industry in this country at that time was largely confined to refining the product of foreign manufacturers. This business was built up; its lines were established. It became necessary, therefore, in installing the production of home-made sugar to conflict somewhat with the already established order of things. Conservatism, the balance wheel of well-regulated business tendencies, refused to respond immediately to the demands of this new industry. Its claims must be demonstrated, and unfortunately by new men. It was also true and unfortunate that the majority of these men were inexperienced in any phase of the sugar business. The intricacies of this industry must first be mastered by them. This was done. They paid for the process, but they learned their lesson so well that they were successful in demonstrating the merits of the beet-sugar industry to the refiners who were responsible for the established order of things. While these were the last to appreciate the merits of the beet-sugar industry, their conversion was probably the most helpful feature in its progress. It is well understood that the refining interests at present are extensively represented in many plants of the country, and some of the largest most successful factories operating in the beet-sugar industry. These same interests are actively projecting many other sugar plants. They are probably now among the most effective and energetic agents in advancing the home production of sugar. They build large up-to-date sugar factories, equipped with modern machinery. As a rule these new plants are being installed in the arid West, where the beets are grown on lands reclaimed by irrigation. They are fulfilling the two demands of civilization—establishing good paying business enterprises and promoting modern civilization by affording employment and sustenance to well-paid American workmen.

THE OUTLOOK FOR FACTORY BUILDING.

I can report, as a further important feature which will culminate in the near future, the many mature and positive prospects for increasing the number of factories in this country. While at times there have been more rumors of factory building, there has never been a time from the inception of the industry when there were so many communities with well-matured plans for establishing factories. Especially is this

true in the irrigated districts of Colorado, Idaho, Wyoming, Montana and western Kansas; and in Wisconsin, and, to some extent, Iowa, the rain belt. There is a healthful revival of factory building throughout all the States now participating in beet-sugar production. It seems quite probable that two or three new States will be added to the list next year.

The mistakes made in the installation of factories due to overcrowding some farming districts, or on account of the inability or disinclination of farmers to furnish the beets for various causes, have been corrected. In most cases such factories have been moved to other places whose capabilities have been fully demonstrated in advance, where they are now in successful operation.

PRODUCTION OF ALCOHOL.

It has been demonstrated that sugar beets are highly productive of alcohol. Two of the leading chemists of this country, after exhaustive experiments, informed me that they could produce alcohol from them at a cost of 10 cents per gallon. France has built up an extensive industry in the production of alcohol from the beet root. Alcohol is produced at one place in this country on a large scale from the refuse molasses of the sugar factories. This throws a new light on the availability of sugar beets as a raw material for manufacturing purposes.

In regard to alcohol, in theory there appears to be great possibilities. It is claimed by chemists that a so-called "denatured" alcohol could be made, to be used solely for fuel and in the arts and sciences, by introducing other ingredients which would render the product absolutely useless for other purposes. It is claimed that there are more units of heat in a gallon of alcohol, costing 10 cents, than in 10 cents worth of any other kind of fuel.

Of course there are obstacles in the way. In addition to the revenue laws, there is the difficulty of coming in conflict with strong, well-established industries engaged in supplying articles of fuel. My purpose at present is simply to outline the possibilities. These appear to be enormous, for alcohol can not only be used as fuel but enters as an important ingredient in varnishes, paints, shellacs, and many other articles.

IMMIGRATION AND THE LABOR SUPPLY.

As an important factor in the progress made, I must call attention to the effects of this industry on the status of labor, not only that directly employed in this industry, but that employed generally throughout the rural districts where beets are grown. I have alluded to this in several earlier reports. We have generally drawn on Europe for a supply of immigrant laborers especially trained in the production of sugar beets. This class of workmen in this country is of many

tionalities, most of them, however, being Europeans. In the beet fields of Europe they have been receiving special training for this work for many years. Our wages are more attractive to them, as well as the opportunities of American life. The building of new factories constantly calls for foreign beet growers. With the increasing permanent demand for this class of labor, we are constantly receiving from Europe an additional supply. It seems to be a feature that gathers force as time continues. Each immigrant, after establishing himself, enters into communication with his friends at home. This eventually bears fruit in inducing others to follow.

The variety of nationalities represented in the beet fields is another thing that portends much, in that it opens up channels of supply from so many different sources. These broaden and become settled avenues of immigration. I wish especially to emphasize the favorable character of such immigrants. They come here with settled habits of industry, with an ambition to become a part of our progressive social organism. Some of them have small means for investment, while all have sturdy manhood. There is an absence of the features marking those immigrants known to our Government bureau as "undesirable." They are not the contract, criminal, or irresponsible class. They desire to better their condition and that of their families, who in time are assimilated, gradually leading to the improvement of our people. It was my privilege during the past summer to meet several advance agents of this class of immigrants investigating the beet fields of this country with a view to settling large bodies of foreign laborers. In effect this means colonization. Many of the workmen were represented to have a little money for investment in homes and land, and an ambition to increase their holdings by their earnings in this country.

Again I must call attention to the helpfulness of this industry. It must be remembered that work in the beet fields is confined mainly to the growing months of the summer. These workmen must provide themselves with employment as nearly as possible the year round. The advantage to farming in general, to factories, and to other lines of industry may readily be discerned. Possibly many of these workmen are drawn into other avocations from the start. Most of them participate in a different line of work during part of the year. The last ten years has developed considerable anxiety among farmers as to their labor supply. Our progressive system tends to an advancement in effort, rather than to fixing an avocation on a class, as in other countries. The American is more and more attracted to the trades and professions. To such an extent has this proceeded that the farmer has been left without a competent supply of help. This condition has been met all over the country. It has received attention from writers on agriculture and the press generally. Any industry that tends to attract a class of workmen back to the fields should be hailed as a

benefactor. The beet fields of this country are a standing advertisement in the agricultural labor districts of Europe for a labor supply which benefits all branches of industry, but especially agriculture. An industry which tends to counteract the depletion of labor in the rural districts must be classed as beneficial.

In the settlement of our new agricultural districts throughout the West we are repeating, in a way, what occurred in the Mississippi Valley some years ago. There can be found districts settled from the older eastern States. In Iowa, Kansas, Nebraska, and elsewhere, are settlements made up almost exclusively from particular States, such settlers being popularly known as "Knickerbockers," "Wolverines," "Keystones," "Buckeyes," "Suckers," "Hoosiers," etc. Probably each of these settlements started with a nucleus of a few families and grew to larger proportions by accretions from the respective home districts. While the same is true to some extent in the far West, we now have, in a more marked degree than ever before, settlements of Germans, Russians, Scandinavians, etc. We have large aggregations of laborers from the countries of southern Europe, all tending to work out the mission of the beet-sugar industry and, incidentally, to help all other enterprises.

In the establishment of a new beet-sugar enterprise assurance of a satisfactory supply of beets is an important prerequisite to success. When the necessary capital has been secured, a proposition is made to the farmers to contract for a sufficient acreage of beets to supply the factory for one to three years. Securing the capital seems to require the least effort of the two. The farmer is naturally conservative. From his experience he is aware that his labor supply has been gradually lessening and wages gradually increasing. This is true throughout the rural districts in all parts of the United States. There has been a gradual movement of laborers from the farms to the cities. It is hard for the farmers to conceive that the introduction of an institution of this kind, making large drafts upon labor supply, would benefit their general condition or that they are in a position to meet its demands. The difficulty, however, is more apparent than real. The labor supply of the farmer has been depleted by the tendency of laborers to leave the farm for the manufacturing industries. A beet-sugar factory must of necessity be located in the district where the beets are grown. As a rule it is not possible for it to be located in a manufacturing center. It is erected in a farming district. Every sugar factory makes an active organized effort to attract sufficient labor to perform the work on the farm and in the factory. The sources of supply are thoroughly canvassed and inducements are offered to bring the laborers into this field. Otherwise, the farmer, as a rule, would be simply dependent upon such laborers as presented

themselves asking for employment. Farmers are not organized for attracting and directing a supply their way. The factory is.

When a new sugar factory is installed, one of the first indications of the changes which are to follow is the arrival of train loads of laborers brought in from various places, generally persons of foreign extraction who are accustomed to doing work in sugar-beet fields. The sugar factory has agents who are active in directing laborers to its locality. When the factory's campaign is over, and the work in the beet fields is done, many of them engage in other work on the farm. In this way the sugar factory improves labor conditions in its locality instead of interfering with them.

I have often referred to the availability of school children, from the age of twelve up to maturity, for this purpose. The major part of the work in the beet fields must be done at a time when the public schools are out, and carloads of these young people can be seen early in the morning on Monday going out to the beet districts to return again Saturday night. This opportunity is a boon to every city and town within easy reach of a beet-growing district. Beets are grown at a time when the laborers can live in tents and board themselves, very little equipment being needed. Young people in these districts are afforded an opportunity of being more nearly self-sustaining by employing their time in weeding, thinning, hoeing, and harvesting beets throughout the vacations of the public schools. They are able to clothe themselves and furnish assistance in supporting the families of which they are members. The work is healthful, and it inculcates industrious habits. Such laborers are paid from $1 to $1.50 per day.

CONDITIONS FAVORABLE TO THE ESTABLISHMENT OF THE BEET-SUGAR INDUSTRY.

Environment has everything to do with the success or failure of the beet-sugar industry. It affects the facilities for producing sugar beets and disposing of them and the finished product, the cost of raw materials, transportation, and many other things.

CLIMATIC CONDITIONS.

Before assuming the responsibility of growing sugar beets for a sugar factory all the conditions must be thoroughly investigated and found favorable. In this connection we will first consider climate. It has been found, as stated, that sugar beets can be grown quite generally throughout the United States. It has been as definitely ascertained that beets may have the proper appearance and form and still not be adapted to sugar making. After all our experiments and investigations we are not able definitely to locate the beet-sugar belt, or, in other words, the area of country adapted to producing beets suited for the sugar factory. It has been found

that meteoric conditions exert important influences. The sugar-making qualities of beets appear to develop better under northern conditions than under southern. This is probably due to the effect of too long-continued constant heat received by the vegetable in the South during its growing period. It is quite generally agreed by scientists who have investigated this phase of the plant's growth that an average of 70° F during the growing season of the beet—estimated to be a hundred days—meets the normal requirements of the beet. Beets grown under such temperature show a much higher quality than those grown under considerably higher average temperature. Just how far such results may be modified by moisture conditions I am not able to state. Beets are grown successfully in California and Arizona and most of the arid valleys of the inter-mountain States.

In some of these areas they receive as much heat during the day as those grown in the lower half of the Mississippi Valley. Indeed, it is such districts that maintain the highest averages of sugar contents during the manufacturing season. While the amount of heat may be quite similar to that found in the Southern States, other conditions appear to exert a modifying influence. Throughout the beet districts of the arid regions the evenings are generally cool. This is usually considered conducive to root-crop growth, and it probably is effective in the elaboration of sugar. The heat received by the beets in the South is accompanied by a more humid condition of the atmosphere, while the air in the arid section is quite dry. Whatever conclusions may finally be reached through scientific investigation regarding the area best adapted to sugar-beet culture, practical experience has demonstrated that we have enough territory adapted in every respect to produce the sugar of the world and provide for the increase of consumption for years to come. It is now apparent that our capacity in this respect is practically unlimited as compared with any ordinary estimate of future consumption. To produce the world's supply of course is not our present ambition. We are concerned at present with the production of a supply for our home market. Barring possible exceptions due to local conditions, the territory north of the middle line of Iowa drawn east and west from the Atlantic to the one hundredth meridian and all the valleys of the intermountain and Pacific States known as arid or semiarid are adapted agriculturally to the production of beets for use in making sugar. There are also many places south of the line indicated in the eastern section that will probably produce them just as well; but in the area indicated experimentation has shown a general tendency to higher sugar contents as we approach the Canadian line. Through a series of experiments, and by noting actual results at the sugar factories, it has been determined that the sugar content of the beets increases with considerable regularity

from south to north in Michigan and Wisconsin. Some of the individual beets testing highest in sugar contents have been grown near the Canadian border from North Dakota to New York.

The decision of the farmer to grow sugar beets is determined largely by the presence or absence of a sugar factory. Questions involving climatic influences in different districts largely concern the factory itself. The conditions favorable to the sugar beet for factory purposes are now pretty well defined—probably as well as the conditions affecting corn or wheat. As far as climatic conditions are concerned, we are not liable to mistakes in location of factories. The factories themselves have been the most effective agents in working out definite conclusions. Of these we have a chain reaching up the western coast from Los Angeles to Spokane, demonstrating the existence of favorable conditions in California, Oregon, and Washington; and in the intermountain States there are factories from Arizona to Idaho accomplishing the same work in Arizona, Utah, Montana, and Idaho. In the States producing crops by rainfall we have another chain of factories, reaching from Nebraska to New York, demonstrating field conditions for growing beets in Nebraska, Minnesota, Wisconsin, Michigan, Ohio, and New York. For some of the factories in all of these States beets are grown in adjoining States or Territories. In this way we have secured a complete demonstration of practical conditions in the whole beet-growing area. Future growth of the industry will simply be based on known conditions. Experience and investigation have accomplished much for the benefit of this industry. It was the important feature lacking in the beginning of its development.

CONDITIONS FOR SECURING FUEL AND LIMESTONE.

Climatic influence is not the only important feature to be considered in the establishment of a beet-sugar factory. The locality may have ideal conditions in this respect and yet not be suitable for a sugar factory. This is a fact that has been demonstrated in the past by actual operation of the industry. There are many things necessary for promoting the facilities of sugar manufacture. In producing sugar from beets certain materials must be used which affect the cost of production. These are fuel, limestone, and other factory supplies. It must be apparent that the cost of fuel varies widely in the different parts of the country. If coal is used it takes an amount equal to about 20 per cent of the weight of beets to manufacture the sugar. This makes an important factor in the cost of production. Its cost in some places would be prohibitive. This condition may be overcome to some extent by the use of other material for fuel. In California the fuel used in the sugar factories is largely crude oil. The same will probably be true in Kansas in the new factories that are to be established there. In Washington up to the present time wood has been largely the fuel

for manufacturing purposes. Most of our factories, however, are located near coal deposits affording cheap fuel.

Of lime rock, a sugar factory consumes an amount equaling in weight from 9 to 11 per cent of the beets worked. The factory should be able to secure a supply of this material as cheaply as possible. In quality the lime rock should be good, with as little as possible of silicates, magnesium, and some other ingredients usually found in lime rock. That which carries the highest percentage of carbonate of lime is most desirable. Our factories generally throughout the country are favorably located for securing a cheap and suitable supply of this material. The ease with which other needed materials may be secured by a sugar factory depends largely upon its proximity to good commercial centers. Of course the securing of these miscellaneous supplies is of smaller importance, but is worthy of consideration in estimating the cost of production.

TRANSPORTATION AND MARKET FACILITIES.

Transportation facilities, whether by rail or by team, have much to do with the successful operation of a sugar factory. The more railroads the better, and it is better still if these roads approach the factory from several directions. This promotes the delivery of beets and other crude material to the factory and the carrying to market of finished products. It very much extends the beet-growing area, as it makes more localities accessible by rail. The same thing may be accomplished by the building of trolley lines throughout the beet-growing district.

Good country roads are an important feature in the operation of a sugar factory. In order to reduce the cost of delivery of beets to the factory, farmers should be able to haul large loads. They usually deliver loads of two to four tons. This requires that the roads be in the best condition as to grade and repair. Six miles is generally considered the outside limit of wagon delivery. When we get beyond this distance we find that farmers consider the long haul of the beets a serious obstacle. Seventy-five miles by rail seems to be the practical limit. Beets are delivered at greater distances than these by wagon and by rail, but beyond the distance limits named the propriety of attempting to extend production is a debatable question.

Much depends upon the market facilities of the sugar factory, its proximity to good-sized towns or commercial centers, and the competition with which it has to deal. Much also depends upon its transportation facilities and the sympathetic relation existing between the factory management and that of the railway. The greater part of the demand for sugar in this country comes from the area lying east of the Mississippi River. Through lines running east and west generally promote better market facilities.

IRRIGATION AND SOIL CONDITIONS.

In a large area of the country where sugar beets are grown an irrigation ditch furnishing throughout the growing period a full and suitable supply of water is a prime necessity. In fact, this is the basis of all agricultural production. Such ditches must furnish a supply of water that will be ample, regular, and permanent. Sometimes it happens that the source of the irrigation water becomes affected by drought, which reduces the quantity of water flowing through the canals and ditches, thus giving a scant supply to the grower at the time when he needs it most. It often happens that the laws and regulations governing water rights are bad. The value of a water right depends largely upon the date of its establishment. As the amount of water becomes less through any cause, the shortage affects those rights of most recent establishment first. There are many intricate and troublesome problems affecting the use of water for irrigation.

As the subject of irrigation is more fully discussed elsewhere in this report (pp. 42–43), it is only necessary here to say that all conditions affecting irrigation should be carefully investigated before an attempt is made to establish the beet-sugar industry in arid sections.

The character and condition of the soil as affecting the growing of the beets must also receive careful consideration; but it has been demonstrated that there are no narrow soil limitations affecting the establishment of this industry. The sugar beet thrives over a wide range of soils provided proper cultural methods are used. Soils and methods of treating them are more fully discussed in another part of this report (pp. 20–24).

SUGAR BEETS AS FOOD FOR LIVE STOCK.

Sugar beets have an important place as a field crop aside from their sugar-producing qualities. Grown as a stock beet, they rank among the first of the root crops which may be used for animal food. They may be fed to hogs, sheep, fattening steers, growing cattle, milk cows, and brood mares. Results of feeding experiment show the following facts: Fed to cows, they increase to a remarkable degree the flow of milk; they promote the fattening of cattle; they not only add materially to the nutritive value of the ration, but they have a sanitary effect in the promotion of digestion. In the feed yard containing a lot of steers fattened on a ration of corn and beets, one can observe very little of undigested grain in the droppings. In this particular the effect of beets is the same as that of pulp. They produce a better quality of meat, as has been shown on the block in many experiments. This applies to pork as well as beef. We find that the steak or the roast is more firm, juicier, and better flavored. These qualities have been noted in the famous roasts and chops of England and Scotland,

produced by feeding mangel-wurzels, turnips, rape, and other succulent root and green vegetable crops. In recognition of some of these facts, I reproduce here what was said by one of the leaders of the Fat Stock Association of Chicago, in a recent interview in Denver, reproduced by the Oklahoma Journal, Oklahoma, September 25, 1905:

Hogs fed on sugar beets make the finest kind of meat, according to Nelson B. Morris, the millionaire Chicago packer, and they command the best prices in the markets. As Colorado is one of the leading States in the production of sugar beets, it means the opening of practically a new industry for that State—that of raising hogs on a large and profitable scale. Colorado can raise more than enough to supply all the sugar plants and to feed thousands upon thousands of hogs. Sugar beets can be raised very cheaply and it will make the raising of hogs a profitable industry. The climate here is also adapted to hogs. "Colorado is admirably adapted to this industry," said Mr. Morris, just before he boarded the afternoon train for Chicago. "This State grows alfalfa, sugar beets, and field peas in abundant quantities, and these are the finest kind of feed for hogs. Colorado should produce the finest hogs in the world."

Outside of the corn belt Mr. Morris declares that there were three great forms of food for hogs which make their flesh firm and develop them in every way into valuable animals for the block. These, he said, were alfalfa, sugar beets, and field peas. These are most valuable as hog foods.

This shows that men of practical affairs are learning what men of the theories have long ago demonstrated by actual experimentation. It would pay any farmer to grow sugar beets and store them for feeding to his farm animals of all kinds. There is too much feeding of grain, especially corn. For this should be substituted a helpful food ration in which root crops form an important part. No better root crop can be used for this purpose than sugar beets. This fact is being demonstrated in feeding experiments at many agricultural experiment stations throughout the United States, and it is being demonstrated by practical feeders and extensive producers of live stock. They are being appreciated more generally by farmers over the country. It was my observation several times during the past harvesting season to note, among other difficulties of sugar factories, that they were losing some of their beets; these were bought up by the farmers for feeding purposes as they were being delivered to the factories. In order to secure the beets, the farmers must necessarily pay as much for them as if delivered to the factory, barring, of course, in some instances, the cost of delivery, the farmer taking the beets from his neighbor, the grower.

As a field crop, for feeding purposes, the sugar beet affects almost the entire country. In the West it makes possible the establishment of the feeding industry in all irrigated districts. A short time ago it was only possible for this western country to prepare stock cattle and sheep for eastern feeders. It contributed to the stock industry only so far as the range could do the work. Hog raising was practically

out of consideration. With the development of irrigation came alfalfa, the field peas, barley, and other cereals, followed by sugar beets, and, in districts having sugar factories, sugar-beet pulp. These stock feeds form a basis for stock rearing and feeding in competition with other States farther east.

When the feeding possibilities are demonstrated, it is easy to see that the foundation is laid for the establishment of the dairy and creamery. When I began the work of investigating this industry nine years ago, the people of the intermountain and coast States bought from producers in the Mississippi Valley and farther east most of their butter, cheese, poultry, prepared meats, and eggs. It is one of the strong probabilities that in the near future these eastern and central States will find in their own markets strong competition coming from farther west.

In my previous reports I have often urged a more general growing of sugar beets purely for feeding purposes. I have suggested three benefits from such practice: (1) It adds materially to the economy of the farm, improves the soil, and introduces better and higher methods of tilth; (2) it furnishes a valuable addition to the supply of feed for live stock; and (3) it educates the farmers in beet growing, thus creating one of the favorable conditions for a sugar factory. By those best posted in stock rearing, it is conceded that farmers are generally too much given to feeding grain, which, fed alone, is too heating and has a tendency to cause digestive disturbances and diseases of various kinds. It has been thought by some that an exclusive ration of corn has a tendency to promote hog cholera. Practical feeders have found that better results can be accomplished by introducing a root crop into the ration, and sugar beets have been especially favored for this purpose.

I have found that some confusion has arisen owing to the limitations governing the production of beets for sugar making—as, for instance, those relating to climatic conditions, size of beets, etc. These limitations apply only to the production of sugar beets for factory purposes and not to growing them for general farm use. They are based entirely on the purity and sugar content of the beet. They do not apply to growing them for stock food. This leads to the further explanation that the cost of production of stock beets is not nearly so great as that of beets for sugar making. The yield per acre should also be very much higher. A farmer who is growing beets for a factory is generally admonished to produce a beet of comparatively small size. This requires time and expense. The cultivation and care throughout is more expensive. Then the delivery of the beets to the factory—one of the leading items of expense—is entirely eliminated when growing beets to be fed on the farm.

Another benefit which comes from growing sugar beets for feeding purposes is the familiarity it gives the farmer with the conditions and methods of culture. The area which possesses proper conditions for growing sugar beets for factory use is extensive. Sooner or later the farmers throughout this area are likely to be asked to grow beets for sugar factories. Without a familiarity with the crop, a farmer is utterly unable to form a wise conclusion on the subject. But growing beets for his stock gives him an opportunity to gain practical information that he can not gain in any other way. Some of the few great mistakes made in this country in the installation of beet-sugar factories resulted from the total absence of experience of this kind. It is gratifying to report that farmers are taking more and more interest in this phase of the subject. I have known some farmers who, after growing the beets for the factory, have preferred to feed them, or a portion of them, rather than deliver them to the factory. Many farmers who grow beets for the factory grow other beets specially for stock. I find in farming districts where there are no sugar factories that the number of farmers who grow beets as a regular crop for feeding purposes is becoming more numerous every year. I feel like insisting that those who have not done so should give this practice a trial.

SUGAR-BEET CULTURE.

THE SOIL AND ITS TREATMENT.

Let us now assume that the problems involving general conditions have been disposed of for the farmer by the location of a sugar factory in his vicinity. He has contracted to grow the beets. He is now face to face with certain problems directly affecting him. The first step of prime necessity is the selection of the soil. Upon this depends much of his future success in the business. If he is a thoughtful farmer, he will eventually make a programme for a rotation of crops and decide in advance what particular land he will devote to sugar-beet growing for several successive years. Some crops precede beet growing better than others and are more effective in leaving the soil in proper condition for planting beets. Such crops permit fall plowing, and this is generally preferable. This plan will also embrace all the crops to be grown in the rotation for several years, and have in view thorough practical fertilization of the land a year or two preceding the putting in of the beets, especially if the fertilizer to be used is ordinary farm-yard manure. These things are merely incidental to choice of land. We are concerned at present more directly with the selection of the soil itself. That selected for planting to beets should be what the farmer considers the strongest and most productive on his farm. If his whole farm consists of this kind of land, then he should grow sugar beets at some period on all parts of it. If it is not, he should

confine himself to what he knows to be the most productive—that upon which he produces his best yields of corn, potatoes, and other field crops. With sugar beets, the kind of soil is not of prime importance. They do well in sandy loam, clay loam, or what is known as clay soil. But whatever land is used must be fertile and capable of being stirred to a considerable depth, say 10 to 12 inches. Sugar beets will not do well in soil underlain with hardpan. Their tap roots strike down to considerable depth. The soil should be of a nature which permits of constant cultivation, one that does not become so compact and hard as to interfere with the cultivation or harvesting of the beets. The harvester of sugar beets, whatever kind may be used, must go down to a considerable depth below the surface, in order to break the tap roots of the beets and lift them. I have seen fields planted to beets which became so hard and compact by harvest time that it was almost impossible for three or four horses to pull the harvester through the ground. The soil must be of a kind that will permit thorough pulverization. This is necessary for preparing the seed bed. The beet must imbed itself in the soil and not be found projecting from the surface at its maturity. Cloddy rough ground, stones, stubble, stumps, etc., tend to prevent the beets from growing as they should. They not only cause the beets to grow above the surface, but make them sprangle and assume an unnatural form. To secure best results, the beet should have a regular tapering form, with its taproot growing directly down. Anything that causes the taproot to divide into two, three, or more branches simply produces a poor beet.

In naming the kinds of soil suitable for factory beets I have had in mind more particularly soils of the rainfall sections of the country. Out in the valleys of the Rockies and the Sierras we have altogether a different kind of soil with a great many varieties, largely of silt formation, resulting from disintegration of the rocks of the higher eminences. These have been found generally adapted to beet growing, providing sufficient moisture can be applied. Sometimes strata of rock near the surface or heavy deposits of alkali may interfere with the growth of the beets. It has been found quite often that the surface shows very little indication of alkali, but on the application of irrigation water the alkali is brought to the surface to such an extent as to interfere with vegetation. Extensive experiments in "leaching" such soils are being conducted in some places. This is accomplished by tiling the land thoroughly and washing the alkali out of the soil by irrigation, allowing the subdrainage to carry it away. Much valuable land is being recovered in this way. Sugar beets are not especially susceptible to injury from alkali in the soil. In it they thrive better than many other field crops. In some places where beets are grown the atmosphere is very dry and evaporation takes place very rapidly. In the early part of the beet's growth they seem to thrive excellently

with no noticeable effects of the presence of alkali, but as the season progresses the sun becomes very hot and evaporation takes place very rapidly. This has a tendency to increase the relative amount of alkali in the water which reaches the rootlets of the beet. The effect of alkali in such cases becomes very marked, and is quite deleterious.

I have stated that sugar beets are adapted to good fertile soils generally, but this applies only to those that have been thoroughly reclaimed. Beets are not a good pioneer or reclamation crop in a general sense. It is of paramount importance in producing beets for factory purposes that they should be kept up to a high sugar content and purity. The former refers to the amount of sugar contained, and the latter to the relative amount of sugar as compared with other solids in the beet. Beets should not be planted on new lands, especially cleared lands, full of decaying vegetation, until these have been thoroughly reclaimed by cultivation, because on such lands there is a notable tendency to grow a good vegetable but of low grade for sugar making. The same tendency occurs on low, damp, sour lands unless they are thoroughly drained and given sufficient time for complete reclamation by cultivation and cropping. Corrals, barnyards, and feed lots broken up and planted to sugar beets are liable to produce beets of low quality and should be avoided. While these are especially adapted for potatoes and corn and many other crops where quantity is the special object, they are not productive of the desired quality in factory beets. The important things to be kept in mind in selecting the soil for sugar beets are two—quality and quantity of the crop. There is no question but the farmer has a prime interest in the quantity of beets grown upon his land. For this reason he is advised to plant on good fertile thoroughly reclaimed land. At the same time he is under contract to produce beets of sufficiently high quality to meet its purposes. Granting that he has accomplished this, then it is to his interest to produce the greatest possible yield of beets from his land. It is probable that he will be able to grow a good quality of beets on most of his land, but in order to compensate him for his effort and the high expense of the beet crop, he must grow the quantity. At the ordinary prices paid for beets by the factories throughout the country it takes 6 or 7 tons per acre to pay the cost of production. It is as evident as it is logical that a farmer can not expect a profit in growing beets on land naturally low in productive power, and the experiment should be avoided. Beyond the cost of production the profits accumulate. An average of 10 tons would give him a net profit of, say, $20 per acre; of 12 tons, $30 per acre. Estimating cost of production at $30 per acre, the average grower of the United States for 1903 realized $12.40 per acre, net profit; in 1904 he realized $22.35 net profit. If we take the average yield of almost any other field crop

and value it at the average selling price and deduct the cost of production, there will appear but very little profit in the business, and in some cases there will be an actual loss.

In considering this matter it must be held in mind that under present conditions there are many factors entering into the estimates of yield and profit in sugar-beet production that do not enter into the same calculations regarding other crops. We must consider the number of new farmers each year producing sugar beets without former experience, the area of new lands upon which beets are grown for the first time, the scarcity of farmers who have been sufficiently educated in the methods which produce best results. Better results will occur when factories become more numerous, the growers have had more experience, and the better class of growers predominate. As time passes there should be a gradual tendency to rise in the average yield of beets and in the amount of sugar they contain. There should also be an equally decided tendency, through the results of experience, toward a lower cost of production. The farmer will realize more per acre on account of the greater yields of beets, more on account of their greater sugar content, and more on account of lessening the cost of production. This is not theory; it is the actual recorded history in Germany, France, Austria-Hungary, and all other beet-sugar countries which have gone through extended experience.

PREPARATION OF THE SOIL FOR BEETS.

Preparation of the soil begins with the arrangement of the cycle of rotation. It is continued during the years of cultivating other crops leading up to the planting of beets. The fertilization of the soil in connection with these other crops is an important step in this preparation. It is good practice whenever possible to fall-plow early and deep. This is especially commendable wherever freezing of the soil takes place. This has a pulverizing effect on the soil and promotes the availability of its plant food. Just before planting, the ground should be given a more shallow stirring. It should be thoroughly harrowed and rolled to pulverize it and compact it. It should be cultivated up to planting time in order to expose the germinating weed and grass seed and destroy them; also, to prevent evaporation of its moisture. Cultivating, harrowing, and rolling are not expensive features when we consider the comparatively small area of ground devoted to growing sugar beets and the amount of land that can be treated in this way by one man and a team.

The best time to kill weeds and grass is when they are young, as soon after germination as possible. This is their tender stage. Weeds and grass, like other plants, after germination do not have as much ability to perpetuate themselves as farther along in life when the plants have developed better root systems. For this reason, we

insist on early stirring of the ground, constant harrowing, and cultivating and rolling (if necessary) up to the time of planting. The beet plants should be given as nearly an even start with the weeds and grass as possible. All of this work lessens the work and the cost of cultivating after the plants are up.

Much depends on the condition of fineness and pulverization of the soil at the time of planting. What has been said of the delicacy of the weed and grass plants at the time of germination is more true of the beets; and, like them again, the beet plant is very hardy after it has passed the first two or three weeks of plant growth. After this it is one of the most hardy plants to be found in the cultivated fields. On the condition of the seed bed depends much of the performance of the crop. In the first place, the cultivations up to the time of planting have conserved the moisture in the soil. If a dry spell should begin at this particular time, the moisture previously in the earth has been preserved for the use of the growing plants. If the soil has been finely pulverized, it will compact up closely around the seeds, conforming to their rough exterior. This enables them better to extract moisture from the soil. If the ground is cloddy or of a coarse granulation, the circulation of the air around the seeds in the soil deprives them of the moisture necessary to germination. This retards and may prevent germination, causing a poor stand. Replanting is always unfortunate to the beet crop. It adds to the expense for both seed and labor. It gives the weeds and grass the start of the beets. Or, let us suppose that the seed has been planted in cloddy or coarsely pulverized ground, that germination has taken place, and that the weather is unusually dry. The young rootlets reaching out from the seed, seeking moisture in a coarse open soil, are killed by the effects of the hot, dry air. This produces the same result as if the germ had been actually killed in the seed before it sprouted. A pulverized compact soil serves greatly to counteract all this. When the young plant begins to send out its rootlets, it is much better protected. These immediately strike out into moist soil, and the conditions are favorable to successful growth.

PLANTING THE SEED.

When the seed bed is properly prepared, the farmer should plant his beet seed under the most favorable weather conditions. The ground should be sufficiently moist, and there should be sufficient warmth to sprout the seed. If the soil is prepared in time and kept in proper condition, the farmer will be able to seize the first favorable opportunity for planting. If beet seed are planted in ground that is lacking in moisture, the beets will come up unevenly. No ground is uniformly moist after being subject to the action of the sun and winds for a period of time. If beet seeds are planted in

soil that is more or less dry, some sprout and come up; others lie dormant, waiting for sufficient moisture. The beets appear irregularly. They come up in spots. Some of the plants push ahead; others are delayed. Such variations will occur in many places in the same row. The farmer finds himself cultivating old and young beets at the same time. In districts where beets are grown by rainfall, the farmer can decide on the proper time for planting by carefully watching the conditions of the soil after rains. In an irrigated district, if it is too dry when he is ready to plant, he gives the soil irrigation, cultivates it, and plants while he has it in the proper shape. This is called "irrigating up" the beets. It is not generally considered desirable, but it is much better than taking hazards in the presence of a dry spell of weather.

Planting is effected by implements called "seeders," specially designed for this purpose. It is the common practice to plant 20 pounds per acre. To the casual observer this might seem like too much seed; but to one long experienced in growing beets it is known to be a necessary safeguard. It is true a great many more plants come up than will be necessary. Sowing 20 pounds of seed to the acre brings the seeds very close to each other in the row. At the same time each seed contains from one to six germs, each of which may produce a plantlet. The purpose is to have enough beets at regular distance in the row after extracting superfluous plants. There are so many things interfering with the germination and growth that it is hazardous to plant a less quantity of beet seed. The importance of a stand is too great to sacrifice it for economy in cost of seed. An extra half-ton of beets resulting from a superior stand will more than pay for all the seed used. We can not afford to quibble over an extra 50 cents or $1 for beet seed.

The seed should be planted from one-half inch to 2 inches deep according to circumstances. Natural conditions in some localities require planting to a greater depth than others. Circumstances modify at different times the depth to which beet seeds should be planted, even on the same land. I believe as a rule irrigated lands require planting to a greater depth than those growing beets under rain conditions. In the latter if the ground is thoroughly moist and warm, a half an inch is preferable. Under such conditions beets will have time to germinate and send out their roots before the surface can dry out. If there is any likelihood of drying, or if the seed must be planted when the soil is not sufficiently moist, they should be planted deeper. Where lands are watered artificially, weeds are not so troublesome as in rain districts. There are not so many outlying places growing weed and grass seeds to be distributed by wind over the cultivated lands. The deeper we plant the beet seed, the longer it takes for the plants to appear above the surface and the better chance the

weeds and grass have to get ahead. The depth to which beet seed should be planted must be determined on the spot at the time according to the conditions.

BREAKING UP THE CRUST.

Tender plants will not thrive where the surface of the ground is compacted or "baked." Even if directions have been followed, the ground constantly cultivated—rolled and harrowed—up to the time of planting, a beating rain is likely to "bake" the soil before the beets come up or soon after. I have seen cases where beet plants have made an energetic effort to come up but have failed on account of the hardness of the crust. Something must be done to overcome this. In one case of this kind some of the farmers became discouraged, plowed up the land, and planted corn; but others put on harrows and rollers to break up and crush the surface and allow the beets to come through, and in this way they secured a good stand of beets. The rain had wrought both good and evil. It had supplied sufficient moisture for perfect germination, but at the same time it had compacted the soil and prevented the egress of the young plants. The harrowing and rolling remedied this. Even when the young plants are through the ground if the soil is compact the harrow should be used with the teeth sloping back to break up the surface. Possibly some of the plants will be destroyed by this, but it must be remembered that this work is done before thinning out takes place. At all events the crust must be broken up. The existence of a crop of beets depends upon it. Then if a sufficient stand of sugar beets is not secured there will still be time enough to replant or devote the land to something else. A proper economy of the farmer's time and land demands that he make an intelligent effort to overcome this difficulty.

BUNCHING AND THINNING.

As a rule the plants should be 7 or 8 inches apart in the row. Bunching is accomplished with a short-handled hand hoe of proper width. With a single stroke most of the surplus plants are removed from the row, leaving the beets in bunches at proper distances apart. From each of these bunches all the plants are removed but a single one. The aim is to leave the most perfect and hardy plant standing. This thinning is done by hand. The operator must, as a rule, get down on his hands and knees, secure firmly in the fingers of one hand the best plant that is to be left, pressing it down moderately. With the other hand the other plants are grasped and extracted from the soil. Whatever weeds and grass may be present should be removed also, and the soft dirt should be pressed around the remaining beet. This work is tedious and necessarily tiresome, as the operator proceeds along the row on

his hands and knees. But it is a very necessary part of the work, and much depends upon the care with which it is done. The grower should take possession of the situation here and never leave off until he has mastered it. There is a time for thinning beets which is most conducive to the success of the crop. This work should be accomplished at this time and not allowed to wait or drag along. Every day adds to the labor of doing it and to the bad effects consequent upon the thinning. It has already been said that a beet seed may contain several germs. These may all sprout, and the roots of the young plants may be more or less entwined. Taking out all but one must necessarily injure its roots to a greater or less extent. The injury should be made as little as possible. This injury is greater if the surplus plants are allowed to remain after the proper time for thinning has come. This delay will also retard the growth and weaken the vitality of the plants which remain, making them more susceptible to injury from insects, diseases, weeds and grass, and drought.

Continuous rains often interfere with bunching and thinning. This often gives grass and weeds a start and allows the plant to become firmly rooted before thinning is accomplished. After the plants have begun to show three leaves bunching and thinning should begin and be rushed through as quickly as possible.

CULTIVATION.

Cultivation of field crops has in view two principal objects: (1) The conservation of the moisture in the soil and (2) the destruction of weeds and grass.

It is evident that the supply of water to be consumed by the plant is of supreme importance. Where beets are grown under rain conditions the grower must understand in case of drought how to conserve to the best advantage the rain his land receives. In case of excess of rain he must know equally well how to remove it to prevent deleterious effects.

In the rain districts, so far as the amount of moisture the plant receives is concerned, we generally assume that human effort counts for little. A careful study of the case will reveal that the individual is a factor of considerable moment in modifying these conditions. In case of excessive rain relief is found through an intelligent and systematic surface or subdrainage. This every farmer should provide for when the land is subject to excesses. In case of scant rainfall or drought the bad effects may be modified by proper systematic cultivation. It too often happens that when a farmer's land becomes dry he ceases to cultivate. Yet this is the time when cultivation should be most regular and constant. This is especially true in the growing of sugar beets. They are vigorous, have a deep and broad root system, and are extensive users of water. Constant cultivation prevents evaporation of the moisture in the soil.

In talking to beet growers I often express it in this way. It is the natural tendency of the soil to form little connecting and capillary tubes ramifying through it and penetrating down to more or less depth. These tubes connect with the surface. The currents of air moving over the tops of the tubes evaporate the water in their surface end. Capillarity pumps more from the soil below through the tubes to take the place of that consumed and soon exhausts the supply. Cultivation prevents this. It breaks off the tops of the tubes in the general crumbling of the soil at the surface and covers them over with a dust mulch. It prevents this action of capillarity and evaporation. This system disturbed soon begins to adjust itself again, however. Therefore cultivate constantly, keeping this surface capillarity broken off and covered up with this dust mulch, preserving the water in the soil for the use of the plant.

We cultivate to stop this evaporation and in this way we conserve the moisture. Cultivation not only preserves the moisture during the time of plant growth, but, if the former cultivation has been properly done, it very much increases the amount of moisture which the soil will take up. It must be clear to anyone that, where the ground is loosened by deep plowing, or by subsoiling, considerably more water will penetrate and remain than where the ground is hard and packed.

Cultivation really begins with stirring the ground, and is continued through the various stages of preparation until time for planting. After the beets are planted, the harrow should be kept going. As soon as the beets appear sufficiently to indicate the outline of the row, cultivators with flat knives, like those generally called "goose feet," should begin the work of cultivation. As the plants get older, these flat knives should be removed and others for deeper cultivation should be used. Cultivation should be kept up as regularly as possible, as it not only removes grass and weeds, but by forming a dust mulch, it conserves the moisture in the soil; therefore, the drier it gets, the more we should cultivate. If necessary, hand hoeing should be resorted to. But it should be the aim to accomplish as much as possible of this cultivation work with the aid of a horse and cultivator. The amount of hand work necessary will depend upon the amount and persistence of the weeds and grass. In the first cultivation plow shields or "fenders" are necessary to keep from covering the beets. It is not permissible to cultivate as close to the row as when the plants are larger. As the plants grow the cultivator is run closer to the row, stirring the soil and throwing around the beets the fine pulverized earth, covering the young weeds and grass, and preventing evaporation from the soil. In Europe a great deal of hand work is given to beet production; possibly more than would be needed if modern implements and horse cultivation were more generally employed. Partly, no doubt from force of habit, the old country insists on hand work, but hand work can not be

necessary when horse power and implements will accomplish the same purpose. These very much increase the amount of work that a single laborer can do. I can see no reason for hoeing except to exterminate grass and weeds. There comes a time when nothing but a hoe will accomplish the purpose. Then it is advisable to hoe, but under no other circumstances. If cultivation has begun early and has been continued constantly through the preparation of the seed bed, planting, bunching, and thinning, horse cultivation will generally fill all the requirements.

After the beets have grown to such a size that the leaves touch between the rows, further cultivation with a horse is likely to do more harm than good. Later cultivation should simply consist of pulling by hand the weeds that appear above the beets.

The beet field receives another and very valuable cultivation when the beets are harvested. It is then ready for planting corn or other cereals, potatoes or other root crops, or being sown to clover and grass.

HARVESTING AND DELIVERY OF BEETS.

Harvesting requires as much care and intelligence as any part of the process of producing the crop of beets. It should be done in as thorough, businesslike a manner as possible.

The cleaner the fields at harvest time, the freer from weeds and grass, the easier will be the work. The looser the ground—provided it is not actually wet and soggy—the better for harvesting beets. It is first necessary to determine the ripeness of the beets. The grower familiar with the action of this crop can readily determine its stage of maturity. The leaves take on a tinge of yellow and show a tendency to droop. This yellow condition becomes uniform throughout the field. But we need not depend entirely on appearance of beets, because a few samples picked here and there and delivered to the factory will determine definitely the stage of maturity of the beets. The chemist of the factory will analyze them to ascertain their sugar contents and purity, and by these determine the condition of the beets.

Every well arranged sugar factory has an expert agriculturist whose business it is to arrange contracts with the farmers who grow beets. In this contract is a provision, giving the agriculturist certain supervision over the beet fields during the growing season. He is the officer who represents the factory's interest in the beet fields, determines the seed to be used, and furnishes it to the farmers. He notifies farmers when beets are ripe and when to deliver them to the factory. In fact, he has charge of all features of the factory's intercourse with farmers. Every beet grower should keep in touch with this officer. From the very nature of things, he must be especially informed on all matters relating to successful beet production.

At the earliest opportunity after beets are ripe they should be harvested. There are always hazards attending beet production at every stage of the growth. At harvest time there is the likelihood of rains or freezing of the ground. In case of excessive rains the beets send out new rootlets, produce new leaves, and start growth generally. When a beet is growing, it is not nearly so high in sugar contents or purity. In case of heavy soaking rain followed by warm growing weather, a beet crop ready for the harvest may be thrown in a short time into a condition rendering the beets unacceptable to the factory. In many cases this makes it necessary to let the beets stand longer to allow the weather to change, the ground to dry out, and the beets to again assume proper condition for harvest. In the northern beet districts—as in New York, Michigan, and Wisconsin—as the harvesting season progresses there is always a liability of the beets freezing in the ground, which stays permanently frozen until spring. In this case the beets are lost altogether. There is a tendency in all districts also for the ground to get very dry, becoming hard and compact. In this case the process of harvesting becomes more difficult. It is good practice to harvest beets as soon as the farmer receives proper notice from the factory that his beets are ready.

All sugar factories have definite capacities for working beets, and it is plain that all of the beets can not be worked at once nor received at once. When the bins of the factory are full, the harvest should continue just the same, but the beets should be siloed. Factories usually pay more for siloed beets than for those delivered directly as harvested. This is on account of their inability to take care of the beets and the extra expense incurred by the farmer in siloing them. It is also to encourage the farmer to harvest his beets at the proper time. Siloing is accomplished by piling the beets in the field in ricks having a base about 5 feet in width and tapering to a heignt of about 4½ feet. Often they are placed in piles of the same dimensions. A few furrows are thrown up on each side of the beets with the aid of a stirring plow. From this loose dirt a coating of 3 or 4 inches of earth is thrown over the beets. Later if the beets must stand into the colder freezing weather some sort of covering material is thrown over the dirt, such as the leaves of beets, straw, or old hay, and more dirt is thrown on top of this. This will protect the beets, as a rule, to the close of the factory's campaign or to such time as they must be delivered to it. Usually some sort of ventilation is arranged in the top of the rick or pile. This is in order to prevent the beets from being too closely confined, which promotes fermentation and decay. This covering is not so much to protect the beets from freezing as to prevent them from drying out or freezing and thawing. A factory does not object seriously to a frozen beet, provided it can be kept frozen until it is worked. Freezing and thawing is the objectionable thing. This

causes inversion of the sugar to take place, fermentation is started, and the beet is rendered useless for the factory's purpose. If the beets are placed in piles and not covered, they will dry out, become wilted, and lose a considerable portion of their weight, and the farmer becomes a loser thereby.

There are several different kinds of beet plows or harvesters. Those in ordinary use are designed to break off the tap root of the beet where it is small and lift the beet 2 or 3 inches, leaving it in an upright position in the loose soil so that it is easily picked up by hand. Some of these harvesters are shaped much like a stirring plow with long slender mouldboard and sharp share moving under the ground at a depth of 13 to 15 inches. Others in their general form above the ground resemble the plow, but instead of having the mouldboard and the share they have two upright parts passing on either side of the row of beets. These at their lower parts have two round horizontal prongs, one passing on either side of the beet. These prongs approach each other near their rear ends. The beet in this way is made to pass through a constantly decreasing crevice, and is thus forced upward until the tap root is broken off.

In covering beets, grass, old leaves, straw, or hay should never be applied to the beets first. It is good practice to use loose dirt for the first covering. If the straw, leaves, or the like are placed on the beets first and followed with a coating of earth, the pressure of the earth causes the straw covering to adhere to the beets. After standing for some time it is quite difficult to remove this trash from the beets. So strong is its adherence that, even after the beets have been soaked in water in the channel through which they are propelled to the washers and elevators, particles still cling to the beets. These seriously interfere with the whole process of cleaning and slicing the beets. Covered first with dirt, then with straw, the beets should be allowed to stand until it can be determined whether they must remain in the silo for a considerable time. If they must, for further protection an additional covering of dirt is thrown on the straw. The straw covering between the two layers of earth affords a better ventilation, also an air chamber which aids in withstanding the action of frost.

In connection with harvesting the question of tare comes up. There is a wide difference in the tare on different deliveries of beets. This is due largely to the condition of the soil from which the beets are harvested. Tare is made up from adhering particles of earth. In sandy soils the earth does not cling as in clay soils, nor in dry soils so much as in wet soils. Some beet growers take more care to remove the dirt before loading the beets than do others.

After the beets have been loosened by the harvester a workman follows and catching up each beet in one hand holds it firmly while by one stroke with a topping knife he removes the crown at the "sun

line," or the line which was coincident with the surface of the ground. The beets are then usually thrown in piles to the left or right, forming a string of piles across the field, but sometimes they are thrown directly into wagons. If thrown in piles, wagons are driven along by the side; the workman picks up two beets, one in each hand, bumps them together slightly in order to jar off the adhering dirt, and throws them into the wagon. Upon the amount of dirt still adhering depends the tare that will be recorded against the beet. Here is a constant source of friction between the factory and the beet growers, especially those who lack experience in harvesting beets.

There is opportunity for economy in harvesting beets. An inexperienced workman can readily lose the farmer considerable by the method of doing the work. In topping, for instance, no more of the beet should be removed than is absolutely necessary to get rid of the leaves and that part of the beet near the top containing a high percentage of impurities. A beet topper will soon familiarize himself with the requirements of this work. His eyes immediately select the place where cleavage should be made. With some beets it is necessary to remove more than with others. To remove more than is necessary is absolute loss. I have stood in beet fields and watched inexperienced toppers whose bad work in clipping off too much must have lost the farmer at least one-fifth of his crop. Again, there are more impurities proportionately near the crown than in other parts. If too much of this part is allowed to remain the purity coefficient is lowered as a whole. In some cases farmers are paid on a sliding scale according to the purity and sugar contents of the beets. From each wagonload or carload a basket of beets is taken as a sample. From this basket a sample is taken for the chemical laboratory of the sugar factory. From this sample the amount of sugar in the beets is ascertained. The farmer is given credit for the sugar content of his whole load, according to the results of this test. If beets improperly topped happen to fall into this sample it is evident that the test will lower the total amount of sugar for which the farmer is paid.

Delivery of beets to the factory is one of the expensive parts of the farmer's operations. The cost varies considerably, according to the distance from the factory, the condition of the roads, and the farmer's facilities for doing the work. While beets are sometimes delivered by wagons for a distance of 10 miles it is not considered advisable to undertake their delivery over a maximum distance of 6 or 7 miles. If they are delivered by railroad much will depend on the freight rate. I have known beets to be hauled as far as 200 miles. As a rule, the greatest distance for railroad shipment should not exceed 75 miles.

It will be apparent that good roads are a supreme necessity in beet-growing districts. I find that beet growing is a great incentive for the betterment of roads. A farmer generally aims to deliver from 2 to 4

tons of beets at a load. He is working under favorable conditions when he can deliver two loads per day. Broad-tired wagons are an advantage. Proper grading and drainage of the roads are of the highest importance. There is a vast difference in the means used to facilitate delivering beets; with experience there seems to be a general tendency toward better facilities.

In delivering beets one farmer throws the beets into the wagon by hand and haul two-horse loads. At the factory he takes an ordinary shovel or beet fork and throw them into the bins. Another farmer uses four horses and employs some labor-saving methods for unloading the beets. For instance, he may spread out nets in the bottom of his wagon box and over its sides in such a way that he can lift with a hoist one-fourth, one-third, or one-half of his load. A crane is used to swing these nets full of beets over the bin, so that the load can be removed very quickly. At some of the factories arrangements are made for dumping a wagonload of beets automatically, the operation only requiring a minute or two. Some factories even have automatic dumps for unloading cars in like manner. Some factories have what are known as country dumps in close proximity to the beet fields. The farmers of a particular district can go to a dump of this kind, which is built on a siding or switch out in the country, drive up an incline until they reach a platform over the car, and, by use of an automatic dump, drop the whole wagonload into the car at once. Arrangements of this kind greatly facilitate the delivery of beets by the farmers and also very much extend the beet-growing area of the sugar factory.

It can be seen readily that the cost of harvesting a crop of sugar beets is one of the chief items of expense. Every possible economy in this work is therefore advisable. The adoption of labor-saving devices and methods depends mainly on the factory. It must provide the automatic dumps both at the factory and along the railroads throughout the beet-growing districts. Every factory can also exert considerable influence on the general character and improvement of roads. So important is the item of harvesting in the cost of producing beets that it is constantly receiving consideration by beet growers' associations and writers on agricultural subjects.

The factories are increasing the shed capacity, so as to accommodate larger deliveries of beets at a time. They are providing better facilities for unloading, so as to accommodate more teams. Sometimes those delivering beets are compelled to wait in a long line their turn at the factory. This consumes time and increases the expense of the farmers. The factories are building more automatic dumps, saving the farmer considerable distance in hauling and obviating congestion at the factory.

The time to deliver beets to a factory is one of the old questions involving more or less controversy between the growers and the factory people. The farmer naturally desires to harvest his beets as soon as they are ready, and deliver them to the factory, thus getting them out of his way, and eliminating further danger of loss. He also wants his money for his crop. The latter, on the other hand, has to consider the expense of building beet sheds on an extensive scale. Many factories adopt, without restriction, the policy of receiving all beets when harvested. If the storage sheds become full, the beets are simply dumped upon the ground near the regular sheds. I have seen as high as 20,000 tons of beets dumped in this manner after permanent frost weather had commenced. In the colder districts, like northern Michigan, Wisconsin, and Minnesota, it is hardly possible to construct sheds which will prevent the freezing of beets. After freezing weather starts, it is apt to continue uniformly cold, thus keeping the beets frozen. Storing beets outside would probably be more successful under such climatic conditions than farther south, where freezing and thawing are likely to occur. I believe it is the general desire and policy of all factories to arrange as fast as possible for a constant and general delivery of beets. There is no doubt that this does much to encourage the production of beets, and plenty of beets is the important problem confronting the factory managements. A sufficient supply of beets is the main thing upon which success depends. I am pleased to note that after a factory's first year there is a constant tendency to the satisfactory adjustment of all matters leading to controversy between the factory and farmer. The grower gradually learns to appreciate the difficulties besetting the factory, and the factory is constantly aware that its own acts are important in their effect on the farmer. From the very necessities of the case the management learns to be liberal in the matter of tare and in furnishing the facilities for saving time and expense in producing and delivering the crop.

USE OF THE TOPS AND LEAVES.

With the inexperienced grower, the best use to make of the tops and leaves of the beets is a question. The tops and crowns of the beets contain considerable quantities of fertilizing elements in available form. It is considered good practice by the best farmers to plow these tops under again, and allow them to decay and add humus and fertility to the soil. Many soils are especially lacking in humus. The disposal of this by-product sometimes develops a difference of opinion and interest between the owner of the land and the renter. The latter is likely to feel that it is not his duty to build up or maintain the fertility of the land. He naturally feels that the beet tops and leaves belong to him, and he wants to store them for feeding to his stock. They form a very succulent, nutritious, and desirable animal food. They are

easily grown and stored. I have also found that, even in cases where the owner of the land is growing his own beets, he deems it preferable to feed this refuse and supply the land with humus and plant food in some other way. For feeding, these tops and leaves are not always stored. In many cases as soon as the crop of beets is harvested, the stock is turned in on them and allowed to forage until they are consumed. A notable case where the preference is given to feeding this refuse rather than to fertilizing the fields is that of the American Beet Sugar Company at Oxnard. This company makes a careful study of everything pertaining to the whole question of sugar production. It owns a large farm and maintains a large herd of cattle, to which it feeds the beet pulp from its sugar factory. After harvest, stock is turned into the beet fields and allowed to consume the tops and leaves.

The owner of the land will have to determine for himself which is the more profitable of the two methods. He must certainly bear in mind that, to keep up the condition and fertility of his land, the tops and leaves must be plowed under or something else substituted. If his beets are grown by tenants and he desires to retain them on the land for fertilizing purposes, an arrangement to that effect should be made. Such arrangements are often made.

ACTUAL AND POSSIBLE YIELDS OF BEETS.

The vitality of the seed is an important factor in securing a stand of beets. If the rows are 18 inches apart and the beets in the row 8 inches apart, an acre will have 139 rows with 311 beets in each row. This gives us 43,329 plants to the acre. If the average weight of beets at maturity is 2 pounds, the product of the acre will be 86,658 pounds of beets, or 43.3 short tons. This presupposes a perfect stand, and that is what the farmer should strive for. Sometimes beets are planted farther apart, but 18 inches between rows is the usual rule in good fertile soil. The farther apart the rows the less the cost of cultivation, the larger the beets, and, as a rule, the lower the quality. If the farmer uses bad judgment in preparing his seed bed, or in selecting his time of planting, or plants seed of low vitality, he has injuriously affected his stand of beets. The average yield per acre of this country in 1904 was 10.47 tons—in round numbers, only one-fourth of an ideal yield. While it would hardly be fair to attribute the entire difference to defective stands, there is no doubt that much of it is due to this cause.

The assumption of 2 pounds as the ideal weight of beets is warranted by actual experience in growing beets. Often beets weighing 5 or 6 pounds are used in a factory. In some districts they are more often over 2 pounds than under. I believe the time is coming in the history of beet production when the farmers will be able to mature at least half of an ideal stand of 2-pound beets. Conservative con-

sideration must bring us all to the same conclusion. This gives an average production of 21.65 tons per acre, worth at present prices, $108.25. If this can be realized, all competitors of the American beet grower will be distanced. Falling prices of sugar on our markets will be met by the increased profits resulting from better yields. The farmer will be able to take less for his beets, thus lowering the cost of sugar production.

There can never be a detrimental factory control over the farmer's product. The factory can not run without sugar beets. These are always in competition with other crops. In the natural order of things the farmer will produce those things on his farm which pay him best. The moment beets get below the competing point he naturally turns to other kinds of farming. On the other hand, the farmer is interested in the success of the factory, and he must realize that no concern of this kind can run for any length of time except upon a paying basis. While the factory management can do something to lower the cost of sugar production by improvement in methods, the greatest opportunity is that which the farmer has to lower cost of production by increasing his tonnage of beets.

FERTILIZATION OF BEET FIELDS.

As a rule our farmers growing beets are not as well advised concerning the problems of plant nutrition as European growers. In Europe, where beets are grown upon high-priced lands, necessity demands a more intimate acquaintance with the soil and methods of replenishing its supply of plant foot.

The fact that a plant must be fed and nurtured in order to have it grow is information that is just dawning on the American farmer. As he grazed his stock formerly by allowing them to hustle for themselves, so has he been planting his crops and allowing them to subsist on whatever nature may have provided in the soil.

We grow beets on land worth from $30 to $300 per acre. In Europe they grow them on land worth from $300 to $1,000 per acre. As a rule, our beets are grown without any artificial application of plant food. In Europe particular attention is given to this feature and the growers produce from 50 to 75 per cent more on the average per acre than we do. It is generally conceded that our lands are naturally richer in plant food and that this condition will exist for some time to come. If we should give the same attention to fertilization, there is every reason to believe that our tonnage of beets per acre would exceed theirs.

In growing sugar beets there are a few principles of plant nutrition that must be kept in mind. Some soils may be abundantly supplied with particular elements necessary to plant life and deficient in others. Each particular kind of soil must be supplied with nutrition according to its needs. A soil may have an ample and balanced supply of

all but one of the necessary elements for promoting plant life and yet on account of that deficiency be practically a poor soil.

Beginning with the plant's germination and considering those things classified as plant food the first and probably the one of most importance is water. Water is necessary in the structural growth of the plant and it is the largest constituent element of most plants. It is the medium of outside contact between the plant and the food elements as they exist in the soil. It takes them up and holds them in solution and presents them to the receiving orifices of the rootlets for circulation and assimilation in the plant.

Dr. Harvey Wiley, Chief of the Bureau of Chemistry, U. S. Department of Agriculture, delivered an address before the American Beet-Sugar Association, held at Washington, D. C., April 12, 1904. A large part of this address was devoted to the plant-food requirements of sugar beets. I think it is one of the most instructive and practical discussions in print on this subject. It is designed to meet our own conditions and the comprehension of the popular reader. I shall review briefly some of the points he made and quote some portions of his address.

Carbon dioxid is one of the properties generally abundant in the air and soil surrounding the beet and in the water entering its circulation. It is one of the chief elements of plant structure, it being estimated that 90 per cent is made up of water and carbon dioxid. These make up 93 to 94 per cent of the total weight of the beet. When it is considered that sugar is purely a carbon compound, we may appreciate the importance of carbon dioxid as an element of plant food for sugar beets. This usually exists in abundance where beets are grown in arid districts, as well as in those where they are grown by rainfall.

Regarding the mineral ingredients of plant foods, Doctor Wiley says:

> If you do away with mineral ingredients of foods you will do away with foods, because the moment you extract from foods the mineral substances you render digestion and assimilation impossible, whether of a plant or of an animal. The movement of juices and plants takes place almost solely by what is known as osmotic pressure. That can not take place in the absence of mineral substances. Hence the minerals in plant foods have a distinct physiological function aside from their incorporation into the tissues of the plants themselves.
>
> There are only 2 pounds of phosphoric acid taken from the soil by a ton of beets, whereas there are 8 pounds of potash; but yet it is just as important that the beets should be fed liberally on phosphoric acid as that they should have a supply of potash. Phosphoric acid is especially valuable in the early stages of the plant growth. The beet is a plant that will take care of itself if you will bring it through its childhood. It is like our "infant industries," it needs protection, especially in the early stages of its existence. When the beet once gets hold, it is amply able to take care of itself. Therefore the primary principle of the fertilization of the beet is to do something to feed, nourish, and strengthen the young plant. It will usually find enough in the soil when its root system and leaf system have developed. The leaf system covers the soil above the beet, protects it from the rays of the sun, and conserves the moisture; and the roots reach out in all directions for nourishment. Phosphoric acid is especially essential in the early stages of its growth, but it must be in soluble form. If you

put phosphoric acid upon beets in the form of ground bone it will do no good. Even if you use a very finely ground soft phosphate rock, which may be decomposed in time in a natural way, it does no good in time to be of any benefit to the young plant at its basic stage when it is most useful. You want to feed the young plant soluble phosphoric acid; that is, phosphates that have been dissolved in sulphuric acid. You want to feed the plant liberally with this, especially when it is young. It may be well to feed the plant two kinds of phosphoric acid, one in a state of solution and one which dissolves later on in the season; but the one which is in a state of solution at once is the one which you should especially give. I do not care much how rich your field is in phosphoric acid naturally you should give it as much as 25 pounds of soluble phosphoric acid per acre and give it just before the time of planting, so that the young plant may have it at hand to draw upon.

It should be applied in the form of acid or superphosphates, which usually have from 10 to 16 per cent of phosphoric acid soluble in water and an additional amount soluble in citrate of ammonia.

Phosphoric acid is very cheap. I do not care how rich your soil is this will give strength to the young plant and help to tide it over the period of weakness through which it has to pass and over many vicissitudes, including the violent twisting and wrenching which are necessary to reduce it to a single plant at the time of thinning. All of these things are hard to resist, and therefore the young plant should have as much of its nourishment at hand as possible.

Another necessary plant food is nitrogen. After the beet begins growing if there is any nitrogen within reach it will take it, and you do not then need to have any care about later supplies of nitrogen, as you want phosphoric acid when the plant is young. Plants only eat nitrogen in the form of nitric acid. You may give them an abundant supply of dried blood or tankage or cotton-seed meal, which are splendid nitrogenous fertilizers, but they do the *young* plant no good at all, because before they can be assimilated by the plant they must be nitrified and that takes two, three, four, five, or six weeks before they are in the form for the plant to eat. Hence that form of fertilizer, although splendid for the future growth of the beet, is of no value to it at all at the time when it needs nitrogen most. Hence another thing which you should give your fields, no matter how rich they are, is a supply of available nitrogen, and the cheapest form of it is nitrate of soda.

I was just going to speak of the quantity per acre. Nitrate of soda is not only absolutely essential for beet culture, but it should be used with the greatest care, because it can do a beet crop an injury if it is injudiciously employed. Hence you must treat your plant in a systematic and sensible way. You want to give it a small quantity of nitrate of soda before planting the seed, incorporating into the soil perhaps one-half of all you want your young plant to have. After it comes up, in ten days or two weeks, apply the other half as a top dressing and stir it in. I should say that 100 pounds per acre would be ample for the needs of your plant, of which 50 pounds should be put into the soil at the time the seed bed is prepared and 50 pounds later on.

Nitrate of soda is extremely soluble in water and the soil has no affinity at all to hold it back. If you mix in a test tube a few grains of nitrate of soda with the soil and pour enough water on it to wash through once you take every trace of that nitrate of soda out of that soil. If you mix potash and phosphoric acid in there, you may wash it for a long time and still some of it will remain. So you see that it needs different treatment from other fertilizing materials; but your plant needs it; all plants must have it. The farmers of this country will never successfully grow beets to compete with the farmers of Europe with an average of 14 tons to the acre until they give their young plants what so many beet farmers do in Europe, a small quantity of nitric acid in a form immediately available for use.

If you should put that nitrate of soda on later in the season you might injure your beets, because it would stimulate them to a fresh growth when the beet should be ripening. Instead of getting the beets rich in sugar you would get a beet pithy and watery, perhaps of large size, but not suitable to manufacture. That is the reason that this element, which is so

essential in producing a beet crop, may be used in a way to injure it, and hence the reason why it must be judiciously employed.

Potash is especially valuable in sandy soils, because those are the soils in which it is deficient. In regard to the character of the soil for growing beets, I will say that it is a crop like Indian corn. It will grow on any kind of land where you will give it something to eat. There are some crops which prefer certain kinds of soil, as wheat, for instance. It is very difficult to grow a good crop of wheat on a sand bed. Wheat needs a clay soil; a heavy clay loam is the best. But beets will grow in a heavy clay if you will put enough lime with the clay to make the soil granular and friable. You have all seen fields that have been turned up by the plow in the spring where there were great clods which were difficult to break up even with a harrow. What does that mean? It means that the soil is deficient in lime. You need not analyze that soil to find it out. I will tell you every time if you will let me look at the kind of clods that are turned over at plowing time in the spring—provided they are not due to artificial tamping—whether or not that soil is deficient in lime. On clay that is so hard and impervious that you would think beets would not grow on it, if you will put on plenty of lime to flocculate it, you can grow a fine crop of beets. In sand, beets grow to perfection if you give them food.

I had a most remarkable experience about fifteen years ago. I was up in northern New York where they had a reclaimed swamp, and in that swamp they had grown a remarkably good crop of beets, not only a good tonnage, but beets which were rich in sugar. I was very much surprised at that, because I would not have thought that beets would grow to perfection on soil like that. Soon after that I was out in Indiana, on the Kankakee River, where the soil is made up of sand heaps and of low places filled with vegetable mold, and on one of those heaps of sand a farmer had grown a good crop of beets with a high content of sugar. Where could you get types of more divergent soils than those two? And yet both of them had grown good crops of beets, in quantity and quality. And so I say that the beet will grow on any kind of soil if you will prepare the soil for it. It will grow in pure sand if you will feed it enough.

Lime is one of the things most lacking in American farming land to-day. You can hardly detect a trace of carbonate of lime in some of our soils, and yet in order that the soil be properly fertile to produce the proper results it should always have a slight excess of lime in it, not because lime is such an essential constituent of the plant, but because of its effect upon other constituents of the soil and upon the nature of the soil itself. I have just told you that organic nitrogen, like dried blood, tankage, and cotton-seed meal, is a splendid nitrogenous fertilizer, but it must first be converted into nitric acid. Then the acid formed retards the development and the growth of bacteria. The moment these organisms begin to convert cotton-seed meal into nitric acid they begin to make the soil acid and tend to hinder their own work and will stop it altogether in a short time unless there is something there to take charge of that acid. There is nothing so good for that as lime. Wherever there is plenty of lime to combine with this nitric acid and form nitrate of lime, nitrification will go on with the greatest vigor and the plants will have an abundant supply of nitrogen in their food; but the very moment that lime is deficient then nitrification goes on with diminished speed and finally stops altogether. That is one of the essential reasons for the usefulness of lime.

You may wonder why the lands in England that have been under cultivation for so many hundreds of years are still fertile; and you wonder why they do not grow acid, and why the bacterial organisms do not cease to work. The reason is that a great part of England is chalk. At the grounds of the great agricultural station in England, you can pick up lumps of chalk all through the soil, and if you pour a little acid on that soil it effervesces like water from a soda fountain. Now there is a soil which you can manure with barnyard manure for an indefinite time and still you will never make it acid, and still you will have nitrification going on with vigor.

I say that our farmers must learn to use lime. The beet farmers have an excess of lime in the refuse of their factories. Thousands of tons of lime cake are thrown out every year, every pound of which is especially valuable and should be carefully preserved and placed on

the fields; and if that is not enough they should buy lime, if necessary, if they have not got limestone on their own land. It is not necessary for it to be burned, except that that is the most convenient way of reducing it to a powder; but ground limestone or ground chalk is just as efficacious. Our people are only now awakening to the fact that they must have lime, and have it in abundance.

I have not said much about applying potash artificially, because soils usually have plenty of potash in them for all immediate wants; but we must look forward to the time when even potash will begin to disappear, especially if we have sandy soil. We can not expect large yields from soils of that kind without a liberal supply of potash.

This discussion anticipates that it is the purpose of the reader to grow sugar beets. While I think it is pertinent and applicable to the production of any crops, I am especially instructing sugar-beet growers. In producing this crop responsibilities are greater, expenses are higher, general results are on a more extensive scale, and larger profits are to be anticipated. For this reason the farmer is presumed before entering the business to be prepared to do those things that will accomplish satisfactory results. If not, he should stick to things in cropping not so hazardous, expensive, or complicated.

It is within the province of every farmer to have his soils analyzed chemically and mechanically to determine their constituents, so that he will know which elements of plant food are there in abundance and which are deficient. With such a bill of particulars before him and with the recommendation of the soil physicist and the chemist he is enabled to intelligently nourish his ground for best results in sugar-beet production. Of course this involves expense. To bring the best results the farmer should utilize those things that make his farm most productive. It is just as necessary for him to be advised and to know where he stands as it is for the merchant or manufacturer. After determining the needs of his farm, he should proceed to supply them through the best agencies at hand.

Like many other good things, fertilizers, through lack of proper information, often become a detriment instead of a benefit. The farmer often sees great returns coming from a piece of land through the use of certain fertilizers. He naturally concludes that these are exactly what his farm needs, and proceeds to give it the same treatment, to its detriment and to his loss financially. This is why we find such a diversity of opinion in farmers' institutes and in discussions through the agricultural press in regard to the use of certain fertilizers. Dealers in fertilizers are like dealers in patent medicines; their advertisements indicate a cure for every evil. It is just as necessary that fertilizers should be used for specific purposes as that medicine should be so used.

Where mineral plant foods are lacking, they must as a rule be procured from the markets in some form or other. But aside from commercial fertilizers, we must not overlook two very important sources of fertility within the reach of every farmer and generally adapted to

all farms. I refer to barnyard manure and green manures. While barnyard manure is very useful it is possible to apply this in a way that is actually harmful. One of the objects of using barnyard manure is to increase the humus in the soil. For this purpose the manure should be well rotted before its application, or it should be applied long enough before cropping to become thoroughly rotted and distributed in the soil. I presume it is in the experience of every farmer that if it is applied in the spring just before the ground is plowed without time for these changes to take place the soil often dries out quicker and is less capable of resisting the drought than otherwise. In growing sugar beets it has usually been found essential to apply manure the summer before fall plowing for beets; or, better still, to grow one crop and then follow with beets. Too much can not be said in favor of this old-fashioned fertilizer. It should be the policy of the farmer to so balance his stock and crop interests as to have enough stock to consume everything grown upon the farm. In this way he establishes a sort of perpetuity in soil fertility. He produces and feeds crops and the residue is carried back in the form of manure for the replenishment of his land. Such farming forms an endless chain, fraught with increasing productiveness and benefits.

Continuous growth of a single crop is detrimental to the land's productive power. Rotation should as a matter of fact be regarded as a feature of fertilization. No matter how well land is replenished with fertilizers or how well cultivated, it still lacks a very necessary feature of plant growth, and that is rest. A change from one kind of crop to another seems in most places to furnish this rest. I quote again from Doctor Wiley's address:

> I do not care how good your soil is it will not be many years before you will find that it will refuse to grow a crop of beets if they are planted every year, even if you should supply plant foods which the crop takes off, because the soil is, as I have described it, a living organism. It is as much alive as an animal or a plant; and as an animal is benefited by a change of pasture and a plant is benefited by a change of locality, so the soil is benefited by a change of crops. It demands change and recreation just as much as a plant or an animal does.

There are certain kinds of crops which are best adapted to the application of fertilizer, especially barnyard manure. Rotation offers the opportunity for building the land up in the proper way at the proper time. It furnishes rest through change. The insertion of legumes in the rotation at the proper periods for replenishing the nitrogen is an important feature in crop rotation.

The principal leguminous crops are clovers, alfalfa, peas, and beans. Any green crop plowed under at the proper time benefits the soil, but it has generally been found preferable to use the legumes for this purpose.

It is not considered necessary or advisable to enter here upon an exhaustive discussion concerning the use of manures and fertilizers

for the improvement of soils. The Department of Agriculture has issued in large editions for free distribution to all applicants the following Farmers' Bulletins which will prove useful to those who wish fuller information on this subject: No. 44, Commercial Fertilizers; No. 192, Barnyard Manure; No. 245, Renovation of Worn-out Soils.

IRRIGATION.

Irrigation is becoming one of the most prominent factors in the agricultural development of this country. Settlement and development were originally confined to land moistened by rainfall. The great area of country west of the 100th meridian has assumed a constantly increasing importance for nearly a half century. First, it was looked upon as a desert; next, it was recognized as a great plain, sparsely provided with vegetation, supporting roving bands of buffalo, deer, antelope, and their enemy, the Indian. Then it became useful for grazing, each animal being allotted a large portion of land. Finally, irrigation was introduced in a small way for the production of grains, tame hay, and other feeds for stock. Irrigation has increased until it has become the dominating force in the agriculture of the West. Strike out the canals and ditches carrying water to the land and all the agricultural development and prosperity would vanish like a mirage or like the ancient civilization of Egypt and some other desert countries, the remains of whose canals and irrigating ditches are found by modern archæological explorers.

Sugar beets have proven very resourceful in irrigation farming. In some places beets are grown entirely by irrigation. In some localities this is true in some years and only partially true in others. Certain districts regularly count on rain for the early part of the beet's growth—say to the middle of the growing season—after which irrigation is necessary. In some other localities it is necessary, as a rule, to "irrigate the beets up" and give them a start, the rainfall coming to their aid later in the season. In still other localities sufficient rain falls to grow a good crop of beets some seasons, while in other seasons full irrigation is necessary.

There can be as much damage done by overirrigation as by lack of it. There is a general tendency to irrigate too heavily. In the artificial application of water the necessity for intelligent action on the part of farmers is very important Water can be administered too often or not often enough, in too great quantities or in too small quantities, or it may be administered at the wrong time. To avoid these mistakes requires careful study and close observation. There appears to be a greater tendency to water beets too much than too little; to water them too often than too seldom. Nothing but intelligence and experience can evolve any safe rule of action.

It is an accepted rule among practical growers that beets should not be irrigated unless they absolutely demand it, as shown by their failure to recuperate after a hot day's sunshine. As long as they recover, the water should be kept off. When they fail to do so, it is evident they are needing moisture, and irrigation should follow. Sometimes after a dry spell the ground is thoroughly soaked by irrigation, and this is suddenly followed by a rainy spell, which, with previous irrigation, oversaturates the soil. Overirrigation is especially damaging in the early stages of the beet's growth. The beet should send down its rootlets and thoroughly intrench itself in the soil. If forced to seek its moisture, it will show a pronounced tendency to do this. If we apply too much moisture to the land while the beet is young, this process is arrested. The beet will depend too much upon the artificial supply and fail to send its roots down and out to provide it with sustenance. When such a beet matures, it is short, ill formed, and unsatisfactory for sugar-making purposes.

After a beet has reached the period of ripening, overirrigation is again very deleterious. It causes the beet to start new growth and send out new laterals and rootlets. This causes a lowering of the sugar content and purity of the beet, and some time is required for recovery.

CLIMATIC CONDITIONS AND FARM AND FACTORY RESULTS FOR 1905.

CALIFORNIA.

The first factory successfully operated in this country was established at Alvarado in 1879. A large sugar factory is still operated at that place. There is probably very little or none of the original machinery in use. If not worn-out, the gradual improvement in machinery would have made necessary its replacement long before this.

While California is generally classed among the semiarid States, beet production was originally carried on there without irrigation. While facilities for irrigation have been considerably developed, and the U. S. Reclamation Service is at present building large irrigation works, the State nevertheless has valleys which regularly produce bountiful crops by rainfall only. One of the crops which has proven successful in these valleys is sugar beets. The area which has been tested in sugar-beet growing embraces the valleys on the coast side of the mountain ranges from Los Angeles northward to San Francisco. Much has been accomplished in supplementing the rainfall by the development of irrigation through the establishment of surface ditches heading in the streams of the foothills and mountains and through artesian wells and pumping stations. It is generally considered that enough water will fall during the rainy season to grow sugar beets. In

the districts where factories are already established, and where irrigation facilities exist, irrigation water is required only to supplement the rainfall. There was a period beginning with 1898 and lasting for three or four years in which the rainfall was very much below normal, as shown by the State's record. Sugar beets, along with other things, suffered on this account. While temporarily inconveniencing beet growers and causing considerable loss, this period of drought led to the establishment of irrigation facilities in many parts of the State, and therefore proved of incalculable permanent benefit. During the season of 1904 abundance of rain fell throughout the State, and good crops were produced. These rains come during the months of January and February. During these months in 1905 the amount of rainfall in southern California was from 10 to 12 inches. As a rule the rains were slow and soaking. The soil is of such nature that water is readily absorbed and held until utilized by the growing crops. Following the rainy season the weather in early spring was quite favorable to beet production. This gave an opportunity to make early planting and secure a good stand and gave the beets a chance to send their roots down and out before dry conditions set in. This is what the beet producers in California desire. The same conditions have been repeated in the early part of the winter of 1906. Up to this date (March 1, 1906) about 11 inches of rain has fallen. Indications point to a prosperous year in beet farming for the campaign of 1906. Crop producers of the State generally look with favor upon the fogs that are more or less prevalent during the growing season. They tend to retard the evaporation of moisture already in the soil.

ALVARADO.—Surrounding Alvarado are hundreds of acres of rich bottom lands made annually prolific in years past by the overflow from the Alameda Creek, which runs through the town. These lands are largely devoted to fruit and vegetable growing. Sugar beets do well here.

Climatic conditions in this section during the season were not uniformly favorable. The quantity of beets produced was not sufficient to maintain a factory through a normal campaign. The sugar contents and purity, however, were considerably above the normal. This has a tendency to compensate for lighter yields and a smaller supply of beets.

CROCKETT.—This plant has been idle for some time. With the beginning of the season indications pointed to its reopening. It has a capacity of 1,200 tons of beets daily. It is designed for refining as well as for manufacturing sugar. Formerly it manufactured sugar during the beet-sugar campaign and refined Hawaiian sugar during the entire year. It is reported that about 3,500 acres were planted to beets, but the beets were so badly injured by blight that not enough

matured to justify the planting. Something like 500 tons were harvested and shipped to another factory.

LOS ALAMITOS.—In this district the early season of 1905 was quite favorable. Up to February 4 about 8½ inches of rain fell. Over 2 inches of this occurred in one precipitation. This had a tendency to insure the beet plantings, which occur from the 1st of February to the early part of March. This district is gradually bringing its beet area under irrigation through a system of artesian wells, some of them flowing and others requiring the use of pumps.

The farmers in this vicinity are learning to use the refuse lime from the factory on their land, as it is deficient in this element. A large amount of stock is fed around this factory upon its pulp product and beet leaves and tops from the fields.

This district produces alfalfa to a considerable extent. Waste molasses from the factory is disposed of by mixing it with the hay, usually when it is stacked.

There has been a remarkable tendency to develop stock feeding in this district, pulp being regarded quite favorably as an element in the ration with alfalfa and other things grown there.

The factory uses California oil for fuel. The campaign begins early at this place, generally in the early part of July, but it was retarded this year on account of the prevalence of cold weather. Several hundred acres of beets were affected by attacks of worms.

The sugar contents and purity of beets grown in this district are generally very high. This year the sugar contents ranged from 16 to 23 per cent and the coefficients of purity averaged 80. Delivery of beets began August 3 and slicing at the factory August 5. I clip from the Anaheim Gazette, a paper published in this district, the following:

> Prosperity is spelled with a large P this year among the growers. As an instance of what may be done with two 6-horse teams and a hired man for three months, George Arthur Garner has a stand of 177 acres of beets from which he will harvest 10 tons per acre. At the usual average of $5 per ton his share of the crop (three-fourths) will bring him $6,637.50. Against this, expenses are charged of $1,896.23, which includes feed for horses, seed, and labor, all but $300 of which was supplied by the sugar company under the usual provisions of the contract. Hence he has been doing business on the company's capital.
>
> After deducting harvest expenses he estimates he will have a net return of about $3,600. It is needless to say he is well satisfied and will continue raising beets. He says: "Get a good early start and the work can be handled easily."
>
> Many farmers have already signed up for their next season's acreage and secured their contracts.
>
> An unusually heavy fall of rain occurred at the latter end of the harvest, 2.69 inches falling in one storm. It is claimed that some beets tested as high as 29 per cent of sugar with an average of 19 and a purity of 82. The factory contract price for next year is announced as $4.50 per ton, with 30 cents additional for each 1 per cent above 12, and 25 cents deduction for beets showing 11 per cent or lower.

SALINAS.—This factory, located in the Salinas Valley, not far distant from San Francisco, has a capacity of 3,000 tons of beets daily. I

believe, however, as a rule the factory runs considerably below this capacity, as the district has never been able to furnish it sufficient beets to run at full capacity. Weather conditions in the early part of the year were favorable for beet plantings, and fields as a rule showed very good stands. Indications in early April were probably as favorable as at the same time in any other season since its beginning. Deliveries of beets began September 11 and slicing September 19.

BETTERAVIA.—This concern, with a capacity of 500 tons daily, began the year of 1905 under most auspicious circumstances. It had a campaign of about one hundred and sixty days. It opened early, working first on refining brown sugar left over. Deliveries of this season's beets began June 12 and slicing June 17. About 7,000 acres were planted to beets, most of these being grown under irrigation. Conditions were favorable to a long campaign. Beets in the district can be planted from the 1st of December to the 1st of April.

CHINO.—This is the first plant established in California by the American Beet Sugar Company. Early in the season climatic conditions were quite favorable. Indications pointed to better results than for several years. A good stand was secured. The crop started off with more than the usual moisture in the soil and indications of a good yield. Later the weather was a little cool for beets, which delayed the harvesting. The campaign began August 21 and closed November 1.

The American Beet Sugar Company has announced the terms under which it will contract to buy beets from growers during the season of 1906. Under the new contract the company will pay a higher price for beets than it has hitherto paid. Under the present contract the farmer received $4.25 per ton for beets averaging 15 per cent of sugar, with an additional 25 cents per ton for each 1 per cent over 15, and a corresponding reduction in case the sugar content fell below that percentage. Under the new contract $3.50 per ton will be paid for beets testing 11 per cent of sugar and 25 cents per ton for each additional per cent over that up to 15 per cent, and 30 cents for each additional per cent above 15. Judging from the average sugar content, as shown by last year's record, this will mean an average increase of 35 cents per ton for beets, and the company pays the freight. This should result in a largely increased acreage.

OXNARD.—At this place is located one of the most important sugar plants in California. It probably averages a larger daily output of sugar than any other plant of the kind in the country. The concern owns considerable land, which it endeavors to handle according to the latest approved methods of farming. It annually feeds a large number of cattle. To its herd are fed large quantities of pulp produced by the factory and the beet tops from the beet fields. On its own land it

conducts experiments for soil improvement through drainage and fertilization. It is one of the most up-to-date concerns of its kind in the country, and its success tends to promote the general interests of the beet-sugar industry. The season started out with abundant rains. Its contracts early in the year aggregated 15,000 acres. It is the aim in this district to have the beet crop planted by the 1st of March. Consequently its sugar campaign begins early. The season continued favorable throughout the growth of the beets, resulting in a crop of more than usual importance. Beet delivery began at the factory July 11, and the factory began slicing July 17. It is estimated that about 13,000 acres were harvested. The season throughout was quite favorable, the beets running high in sugar and purity and continuing good to the last.

COLORADO.

This State holds a unique position in the history of development of the beet-sugar industry. It entered the field at a comparatively recent date, but already 12 large plants have been installed. Their locations and daily capacities for working beets are as follows:

	Tons.		Tons.
Rocky Ford	1,000	Loveland	1,200
Lamar	400	New Windsor	600
Holly	600	Longmont	1,200
Sugar City	500	Fort Collins	1,200
Eaton	600	Sterling	600
Greeley	800	Grand Junction	500

Three other factories are now being constructed in the State—one located at Brush and one at Fort Morgan, each with 600 tons capacity, and another at Swink, with a capacity of 1,200 tons. These will give the State 15 factories. It is quite probable that two or three more will be built during 1906 for the campaign beginning in the fall of 1907. Seven factories, namely, those at Eaton, Greeley, Loveland, New Windsor, Longmont, Fort Collins, and Sterling are associated together under the management of The Great Western Sugar Company, with headquarters at Denver. Those building at Brush and Fort Morgan, Colo., will be associated under the same management. The factories at Rocky Ford and Lamar are under the American Beet Sugar Company, having western headquarters at Denver.

The first factory was installed at Grand Junction in 1899, and all the others since that time. The fifteen factories have an aggregate daily capacity for working 11,600 tons of beets, and an approximate daily capacity for producing 1,276 tons of sugar. Assuming the average campaign to be 100 days, the State's production with its present capacity would be 127,600 tons of sugar annually. Valuing this sugar at $100 per ton, this annual product represents $12,760,000.

The agricultural interests of the State generally are progressing as rapidly as the sugar industry. This industry has stimulated all sorts of improvements. Stock feeding is developing with every indication that this will be a prominent agricultural feature.

Prior to the advent of the sugar industry the State had been known principally for its mining interests. According to the latest records its production of the precious metals in 1905 was as follows: Gold valued at $25,535,057; silver, $8,501,233; total, $34,036,290. If the production of copper, lead, and zinc be added to this, the total is increased to $45,257,522. These figures are taken from the official statements of the bullion received at the United States mints and returns made by smelting companies, as compiled and printed by the Denver Republican in its Annual, January 1, 1906.

In the issue of the Denver Post for December 31, 1905, is a résumé of the agricultural productions of Colorado for the year. The data, which were also gathered from official sources, are as follows:

Farm and range products of Colorado for 1905.

Hay	$16,000,000	
Sugar beets	7,500,000	
Dairy products	10,000,000	
Fruit	10,400,000	
Potatoes	4,000,000	
Wheat	4,500,000	
Vegetables	2,250,000	
Oats	3,000,000	
Corn	1,000,000	
Field peas	1,500,000	
Barley	300,000	
Rye	30,000	
Total plant productions		$60,480,000
Cattle	22,000,000	
Milch cows	4,314,000	
Sheep	8,000,000	
Hogs	975,000	
Horses	11,200,000	
Mules	3,000,000	
Wool crop	2,500,000	
Total animal products		51,989,000
Total products for 1905		112,469,000

According to these statistics the agriculture of Colorado is fast outstripping its mines as a source of wealth.

Success has attended the development of the beet-sugar industry in Colorado from the beginning. The beets are grown mostly by irrigation. Plants have been erected only in places having sufficient permanent and regular supplies of water.

The season of 1905, taken as a whole, was better than usual. The rainfall was ample for the preparation of the land and for the planting and germination of beet seed. A good stand was secured generally. The low price of other commodities produced on the farm coupled with the regularity of prices of beets induced more farmers to take up the beet culture. By the middle of April planting was in progress quite generally throughout the State. It is estimated that for the seven factories in the northern part of the State 60,000 acres were planted. Making all the usual allowances, the production of beets can safely be estimated at 630,000 tons, which will return to the farmers $3,150,000. This amount of money will be distributed in seven localities only. The weather continued throughout the season more than usually favorable, and the production of beets may be fairly rated as normal. Rainfall has materially aided irrigation.

ROCKY FORD.—The American Beet Sugar Company operates a factory at this place of 1,000 tons daily capacity. It was the second installed in the State, and is one of the most successful in the United States. Beets are grown largely by irrigation supplied from the Arkansas River. The results of the work of this factory have been largely instrumental in stimulating interest in sugar production throughout the State. By producing its own beets, this company has built up sugar-beet production in its district to such an extent that it has been found necessary to install two other plants to use the supply, namely, those at Holly and Lamar.

The season, though quite unfavorable to many other crops, such as alfalfa, cantaloupes, and fruit, was not unfavorable for sugar beets. A good stand was secured and the crop continued as a rule to thrive. It appears probable that the factories in this district can continue to count on the cooperation of the farmers. The factory pays $5 per ton for beets delivered by wagon or on board cars at the stations. Harvesting began September 25. The factory began operations October 2 and closed about February 15.

This factory lost by fire during the campaign about 5,500 tons of sugar, valued at $465,000. This loss was occasioned by the burning of the sugar warehouse, the fire probably originating from defective electric-light wiring or spontaneous combustion.

LAMAR.—The American Beet Sugar Company moved a factory from Norfolk, Nebr., to this place and installed it during the past season, increasing its capacity to 400 tons of beets daily. Beets have been grown at Lamar to a considerable extent for the factory at Rocky Ford, about 60 miles farther west. Consequently beet culture was not a new thing to the farmers here. Contracts covering about 6,000 acres were secured. The planting of beets was finished early in May. In addition to beets grown for this factory, growers in this county also

furnished a supply to the Rocky Ford factory. Over 7,000 acres of beets were grown altogether. The early season was generally quite favorable. Water for irrigation was secured in abundance. Crop conditions were normal. The factory pays $5 per ton for beets delivered by wagon or on board cars at the stations. The factory started September 25, first testing its machinery preparatory to regular operations. Harvesting began September 27. Factory operations began October 2. Three hundred men were employed in the factory. Beets were very satisfactory.

HOLLY.—A plant of 600 tons daily capacity was installed at this place during the season. It had contracts covering 6,000 acres of beets, and this area was planted. Its lands are irrigated from the Arkansas River. Spring rains were sufficient for the planting and germination of the beet crop, though the early season continued quite cold, which had a tendency to retard the growth of the plants. As a rule the stand was good and indications continued to point to a favorable beet-crop season. Some replantings were necessary on account of the wet spring. On the whole, results may be counted as favorable, and the first campaign of the factory more than usually successful.

SUGAR CITY.—A factory of 500 tons daily capacity is located at this place. It was the third to be installed in the State. The company owns about 12,000 acres of land. Its beet lands are watered through irrigation from the Arkansas River. It is especially fortunate in its water rights. It owns two lakes, known as the Twin Lakes, in the mountains near Leadville, about 200 miles distant. The water from these lakes is measured into the Arkansas River near them. The same amount of water is again measured to the factory out of the Arkansas River into its own ditches leading from the river to the factory lands. It owns a large storage lake, called Lake Henry, on a higher elevation than the beet lands; to this its main ditches lead. When this becomes full it has another smaller reservoir, known as Lake Meredith, near the factory, into which the waters are spilled and from the latter distributed to beet lands on the lower levels. In all these factories in the irrigation districts rainfall is generally preferable for planting and germination of beet seeds. In this district natural moisture was quite sufficient and the season opened very auspiciously. Five thousand acres were contracted for. Alfalfa is one of the principal crops here, and it is found quite desirable to have alfalfa precede beets. The middle of May practically all of the beet fields were bunched and thinned.

The season continued favorable throughout the growing period of the beets. Worms appeared to some extent, but no material damage resulted. From beginning to end the season was several weeks earlier than last year. Grasshoppers appeared in sufficient number

to do material damage to other products, but attacked sugar beets very little.

The factory installed an automatic country dump in one of its outlying beet-growing districts to expedite beet delivery and encourage further beet production. The season can be summed up as one of the most favorable experienced by the factory since its commencement. Its supply of beets was larger and the campaign longer. Beets were up to the average in sugar contents and purity. The tonnage was up to anticipation. The average content of sugar for the first week was 18 per cent. The general factory averages were 16 per cent sugar with a purity of 84. The company has a steam plow for breaking up the land. Considerable stock is fed around this factory, and the resulting barnyard manure placed on the land for fertilization. The factory stopped slicing beets December 24. The management contemplates doubling the capacity of the concern and installing the Steffens process.

EATON.—In the Eaton district conditions are quite similar to those at Greeley. Alfalfa, potatoes, and wheat have been the principal farm products. The beet growers of this district have been well accustomed to field cropping. Contracts for the season covered about 5,600 acres. The company pays $5 per ton for beets.

GREELEY.—From the beginning work and conditions at this factory have been ideal. It is well established agriculturally. Where developed the district has been largely devoted to the production of potatoes, alfalfa, and wheat. These are well adapted to rotation with sugar beets. Some of the factories in Colorado have necessarily been established in districts where agricultural methods and resources have not been well developed, but Greeley is in one of the oldest and best developed districts in the State. It is estimated that the contracts for the factory's supply of beets covered about 8,000 acres. The company pays $5 per ton for beets.

LOVELAND.—The factory located at this place is one of the largest in northern Colorado. It arranged contracts with farmers for 14,000 acres of beets for the campaign of 1905. The company operates a railroad of its own, east of Loveland, 20 miles long and fully equipped with rolling stock. This road is operated purely in the interest of sugar production. It traverses beet fields, conveys the raw materials as well as the finished products, and connects through its switching facilities with other roads. During the season a great many improvements were made at the factory proper. In the past the factory has experienced more or less trouble on account of congestion of beets at the delivery season. Often many thousands of tons were piled up on the ground in its yards. Storage bins of three-fourths its capacity were installed this season. In addition to this it put in a Steffens plant, to work on the waste molasses for a further

recovery of the sugar contained therein. It is estimated that about $300,000 was expended on improvements. The tonnage of beets for the season was estimated at 150,000 tons. The campaign opened about October 1. The season continued quite favorable throughout the early part. Slicing began October 2. A considerable portion of the beets produced for this factory were turned over to the factories at Longmont and Fort Collins on account of exceedingly heavy growth in the Loveland district.

NEW WINDSOR.—The factory at this place enjoyed conditions quite similar to those described for Eaton and Greeley. It is also located in one of the old well-established farming districts where irrigation is well advanced and thoroughly understood. In fact it is located near Greeley and Eaton. Contracts were made for the growing of nearly 7,000 acres of beets for the campaign of 1905. The hand work of growing beets in this section—including Greeley, Eaton, and New Windsor—is done mainly by 1,500 foreign laborers, largely Russian and Japanese. Delivery of beets began September 23. The factory began slicing September 26. The campaign ran over 100 days.

LONGMONT.—The capacity of the factory at this place was increased prior to the campaign to 1,200 tons daily capacity. It contracted with the farmers for about 7,500 acres of beets. Along with the rest of the factories in northern Colorado it experienced a favorable season, considering everything. The agriculturist says the tonnage in most cases was satisfactory. The crop is not quite up to that of last year. With more late water the crop could have been increased. The sugar content of the beets was all right. The harvest began September 25, and slicing beets October 10.

FORT COLLINS.—The factory at this place also enjoys the advantage of being located in an old established farming district, which is also the home of the State agricultural college and experiment station, the mutual relation existing between the two being naturally quite beneficial. The station is conducting many experiments in beet growing and stock feeding with the by-products of the factory. This year contracts were secured for about 10,000 acres. The season started quite early and was on the whole favorable to beet planting.

An association known as the Fort Collins Beet Growers' Association, composed mostly of business men, planted about 1,000 acres of beets purely as a business enterprise. The sugar-storage capacity was increased to about 20,000 tons. The factory began slicing October 4. The crop was estimated at 120,000 tons of beets. About 500 men are employed. The estimated acreage planted was 10,003, an increase of 4,000 acres over 1904. The average tonnage was a fraction under 12 tons per acre, as against 13.2 tons the year before. That falling off was due to planting new lands. The highest tonnage was 25 per acre, the lowest 7.

STERLING.—The factory located at this place was one of the new ones beginning its first campaign this year. The district had been growing beets for three or four years quite extensively, most of them being disposed of to the factory at Eaton. About 7,500 acres were covered by the contracts for producing beets for the first campaign. This is one of the factories associated under the name of The Great Western Sugar Company. Its capacity for working beets is 600 tons daily. It is located on the Union Pacific Railroad. Lands are irrigated with water from the Platte River. The factory commenced slicing November 7.

GRAND JUNCTION.—The factory at this place was the first one installed in the State. Its original capacity was 350 tons, but during the season it was increased to 500 tons. The factory beet-growing area is located in one of the finest fruit-growing sections of the State. The management of this plant found it necessary to insure its annual supply of beets by having land of its own and devoting it to this purpose and the production of other crops in rotation. It now owns nearly 5,000 acres of land. It is in a position to command the situation in regard to its beet supply. At the beginning of the season it had under contract 5,500 acres of beets. This district enjoyed, with the rest of Colorado, generally favorable conditions. Estimates made August 1 placed the crop at 40,000 tons on an acreage of 4,000 planted. The factory began operations October 7, and stopped slicing December 20; it had a satisfactory run, but the beets were not up to expectations.

IDAHO.

Agriculturally Idaho has been considered one of the newest and least developed States in the Union, but during the year agricultural development has received a remarkable impetus. This was brought about largely by the installation of the sugar industry. Experiments had developed that the soil passessed rare qualities for producing sugar beets. Previous to this season three factories have been installed in the State, located as follows: One at Idaho Falls with 1,200 tons daily capacity, another of the same size at Sugar, and one at Blackfoot with 600 tons daily capacity. All of these are in the southeastern portions of the State. Water for irrigating the land comes from the Snake River. The building of two other factories has been contracted for—one to be in readiness for the campaign of 1906 and one for that of 1907. The first is located at Nampa and will have a daily capacity of 600 tons, and the second at Payette, with the same capacity. The three factories operating in the State this season are associated together under the name of Idaho Sugar Company, the main office being at Salt Lake City, Utah. The establishment of these great plants in a sparsely-settled, undeveloped section has done much to call attention to the general resources of the State and to promote

its development. The Snake River traverses the southern section of the State and up its western boundary to a considerable extent. Located along its course are many beautiful fertile valleys capable of high development agriculturally. Its crop resources are good generally. Root crops and deciduous fruits of many varieties grow well. All fruit and vegetable products grown in the State have generally been of a high quality. At the present time probably no other section in the United States is receiving as much attention as these districts of Idaho. Settlement is fostered mainly by the results of sugar production and the facilities afforded. Not alone along the Snake River but throughout the valleys in its interior to its northern boundary are many districts capable of developing a water supply and agricultural resources for production equal to those along this river. The establishment of these five large plants indicates a recognition of its resources by the capitalist and the home builder.

IDAHO FALLS.—A factory of 1,200 tons daily capacity has been in operation for two seasons past. The factory was able to secure the planting of 6,000 acres to beets. The rainfall was quite sufficient in the early season, and this was followed by further rains and cold weather. Finally the season settled down to good growing weather and continued quite favorable for beet production throughout the rest of the season. The factory started October 9. The estimated length of the campaign was one hundred days. Between 5,000 and 6,000 acres were harvested.

SUGAR.—Farmers went into beet production with more zest on account of experience with other crops. The difficulties of fruit growing and demoralization in prices of other products compared with the regularity of the beet crop under the same circumstances has had a tendency to elevate beet production throughout the district. Weather conditions started out quite favorable. The factory located at this place has a daily capacity of 1,200 tons. Two spurs were built during the season to extend railroad facilities through the beet-growing districts. Eight thousand acres under contract were planted to beets, thus insuring the factory a satisfactory supply. Among the improvements inaugurated in this factory was the installation of the Steffens process for recovering sugar from waste molasses. By May 10 most of the beets were planted and up. Weather conditions during the growing season were generally favorable to producing a good yield.

BLACKFOOT.—A factory of 600 tons daily capacity was installed at this place in time for the campaign of last year. The early season was quite favorable for beet planting. This was followed by cold wet weather which retarded germination. As the season developed, conditions became more settled and quite favorable to beet production and continued so throughout the growing season. Though the weather was favorable the water in Snake River became quite low,

reducing the supply of irrigation water and interfering to a considerable extent with the development of the crop. It was determined that water was being too freely used farther up the river, in fact, wasted. Through an order of the court this matter was adjusted, after which beet growers in the Blackfoot district secured a more ample supply of water. The factory began slicing October 9. On July 6, 1905, this factory became, through purchase, a part of the holdings of the Idaho Sugar Company.

ILLINOIS.

The State of Illinois has done much experimental work to test conditions for growing sugar beets. The investigations show that the State has conditions favorable to the establishing of the beet-sugar industry. It has great commercial centers, transportation facilities, and resources. The soil is productive of beets of the quality desired for factory use. Some years ago a factory was established at Pekin. It happened that the season during which this factory attempted to operate was quite unfavorable for the production of any crops, including of course sugar beets. There were differences of opinion among the management of this institution. It ran for one year, closed down, and was dismantled. The building and some parts of the machinery were used for another purpose. This resulted in the abandonment of beet-sugar production before it had had a fair trial in the State. This experience has had a discouraging influence on all subsequent attempts. There are many places throughout the State where investigations have developed favorable conditions. Beets have been grown to a considerable extent in the northern portion of Illinois for factories in Michigan. In the district east of Chicago, and south of Lake Michigan, about 1,200 acres were grown at one time for the plant at Kalamazoo, Mich. The yield and quality of the beets were good. Personally, I am convinced that there are many places in the State well adapted to beet-sugar production and that this fact will eventually be recognized. The advantages of manufacturing sugar in a district having the great commercial facilities possessed by northern Illinois can not long be overlooked. The advantages of Chicago as a distributing point for such a commodity, and the ramifications of railroads reaching the markets in every direction, along with the natural conditions favorable to beet production, will some day impress investors.

RIVERDALE.—During the past season Mr. Charles Pope, of Chicago, built and equipped a factory at Riverdale, a few miles from Chicago. It was not the purpose to attempt anything this season, but a trial campaign. An active effort was not put forth to secure a large acreage of beets. The factory is of 350 tons capacity, but will be enlarged as conditions warrant. The beets grown for it this season were satisfactory in quality and quantity. The results of the campaign were suffi-

ciently encouraging to warrant a greater effort for next campaign and confidence in the future success of the enterprise. The factory began operations October 15.

MICHIGAN.

This State still continues to hold a larger number of beet-sugar factories than any other. It has installed since the beginning of the industry twenty-four factories. Of this number four have been moved to other places in the United States and Canada, two more are to be removed, and another is idle. These removals were largely due to the establishment of too many factories in districts where the farmers lacked experience in beet growing. The installation proceeded too rapidly. The first factory was installed at Bay City in 1898. The others were built in rapid succession. Michigan's development agriculturally was not sufficient to justify this rapid industrial growth. The locations of those in operation in the State at the present time and their capacities are shown in the following table:

	Tons.		Tons.
Bay City	500	Carrollton	800
Caro	1,200	Salzburg	400
West Bay City	600	Sebewaing	600
Alma	750	Mount Clemens	600
Holland	350	Croswell	600
Marine City	350	Menominee	1,000
Lansing	600	St. Louis	600
Owosso	1,000	Blissfield	600

At Bay City there are two plants—one known as the "Michigan" with 500 tons daily capacity, and another known as the "Bay City" with 600 tons daily capacity. The ownership of the two was merged in a company known as the Bay City-Michigan Sugar Company. The "Michigan" factory has been idle for the past two campaigns. Beets grown for both are worked at the "Bay City" plant.

Gradually the State is developing its resources to the point of supplying the factories now in operation. Each year adds additional experience to the beet growers. They are becoming more accustomed to the crop, are appreciating the advantages to a greater extent, and tending to produce a larger supply of beets. The factories in this State must content themselves, however, with shorter campaigns and smaller supplies of beets than those in any other section of the country. Persistently the State is developing a permanent class of beet growers who are gradually increasing their plantings each year. At this time it appears probable that beet growing will eventually develop to the extent of supplying the present factory capacity. Until such time, factory building is not likely to occur to any extent. However, a new factory was built at Blissfield, and was operated during the past campaign for the first time. Some of the factories procured more than the

usual amount of acreage while others were still below the normal amount.

Weather conditions throughout the State were quite favorable to early planting and germination of the seed, but not so favorable to growth in the early summer on account of excessive rains and cold wet weather generally. This delayed the work of bunching, thinning, and weeding beets, throwing the farmers behind with their work. As a rule the fields here are not large, which is an advantage under such conditions. In some places floods have occurred, washing the beets out and destroying the crops entirely. The weather the latter part of the season became uniformly favorable to the beet crop. Throughout October and November, in fact most of the harvesting period, weather conditions were ideal. This maintained the quality of the beets and enabled the farmers to get out their crop in better condition and at less expense than usually.

BAY CITY.—Cold wet weather interfered with planting, throwing the crop backward in its growth. The management made an earnest endeavor to secure sufficient acreage to run the Bay City plant during an ordinary term. Material losses occurred in the planted areas caused by heavy rains. Although this is the oldest beet-growing district in the State, beet culture and the interests of the industry have not developed in accordance with the deserts of the district. This is due largely to the proximity of several factories in the district, all demanding beets from so limited a farming area. The company began slicing October 12 and closed December 20.

CARO.—The plant at this place has been more than ordinarily successful, as compared with others in the State. It experienced considerable difficulty during the planting season the latter part of May and early part of June, on account of excessive rains and wet cold weather. This did not do so much damage to beets that were actually planted, but it prevented the planting of some fields. The weather during the latter part of June became quite favorable to beet culture and continued so the remainder of the season. With the rest of the factories of Michigan, the district enjoyed favorable harvest conditions. Under test, beets showed more than the usual quality. The factory commenced slicing October 19.

WEST BAY CITY.—The season was not considered favorable, there being too much cold, rainy weather. Conditions were quite favorable for harvest. The sugar contents and purity of the beets were higher than usual. The plant finished slicing December 10.

ALMA.—The plant at this place has been well managed and generally considered quite successful. On account of excessive rains early planting was prevented. The company secured contracts for a large acreage, but rains prevented the planting of some of this. Later in the season weather conditions became more favorable. A better

crop was raised in the district than was anticipated. Farmers have taken to beet growing more generally than around most of the factories in the State. The influence of the industry is felt throughout the district. Roads have been improved, and farm rents and land values have increased. The campaign began October 29 and closed December 23.

HOLLAND.—The sugar factory at this place has been one of the most successfully conducted in the State. Sufficient acreage for a supply of beets was secured with very little effort. The contracts covered about 3,700 acres. The season opened favorable for planting, after which came weather too cold and wet for successful beet growing. In some places the beets were washed out by floods, making replanting necessary. Fortunately the flooding occurred early. It was estimated that about 85 per cent of the acreage originally contracted for was harvested with normal yield.

MARINE CITY.—The acreage reported as secured was 5,000 acres. The acreage covered by its contracts was sufficient if weather conditions had been more favorable. The cold, wet weather in the early part of the season delayed the crop somewhat. A favorable change of the weather occurred in July. The yield was not as satisfactory as anticipated. A considerable quantity of beets are shipped to this plant from Canada. The campaign started October 17, but was comparatively short.

LANSING.—Beet planting was conducted in this district under quite favorable circumstances, but, like many other portions of the State, it experienced in June heavy rains which washed out the beets and prevented the farmers working the fields. The factory contracts covered about 5,000 acres. During the latter part of June weather conditions became quite favorable to beet production. The crop generally was above normal. The factory commenced slicing October 17.

OWOSSO.—Eight thousand acres of beets were contracted. About one-seventh of this was near enough for the beets to be delivered by wagon, the rest of the beets reaching the factory by rail. Considerable replanting was necessary on account of unfavorable weather conditions in the early part of the season. These conditions also affected other crops materially. The beet crop matured with fairly good results. The factory was able to work about three-fourths of an average campaign.

CARROLLTON.—The factory at this place secured about 7,000 acres under contract. It arranged for many Russian families to work in the beet fields. These proved quite effective in cleaning the beets of the weeds and grass and getting them into a healthful state of growth by cultivation. As the season progressed the weather became more favorable for beet production in the district. The results were better

than anticipated. In order to facilitate the delivery of beets the factory established delivery weighing stations in several different towns to accommodate the areas growing its beets. This year's crop in Saginaw County, while fair, has been by no means good.

SALZBURG.—This factory is probably the most uniformly successful plant in the State. It is organized on the cooperative plan. Most of the farmers growing the beets are stockholders of the concern. For this reason a greater interest is generally manifested. Growers were considerably discouraged in the early part of the season on account of the cold rains, which interfered with planting and germination, and retarded the growth of the beets, and at the same time facilitated the growth of weeds and grass. Weather conditions improved gradually after the first of June, continuing superb throughout July and August. Conditions were quite favorable to ripening and harvesting. The plant closed its campaign December 9 with results better than anticipated.

SEBEWAING.—The factory at this place secured a large acreage for beets. Wet weather in the early spring interfered somewhat with planting beets in the district. Their growth was also more or less retarded by excessive rains. With the weather more favorable from the middle of July on, the situation appeared more encouraging.

MOUNT CLEMENS.—The factory at this place secured a fairly good acreage under contracts. As in most places in Michigan, planting was interfered with and retarded by the action of rains and later cold weather. Some of the fields became too weedy to cultivate on this account. The factory began slicing beets October 23.

CROSWELL.—Four thousand acres of beets were contracted for, 800 acres being in the vicinity of Croswell. The farmers were able through the aid of favorable weather to get most of their beets planted early. Cold, wet weather followed, retarding to some extent the development of the crop. The Croswell factory closed its campaign about December 1.

MENOMINEE.—This is one of the most northerly factories in the State and one of the most recently installed. A good portion of its beets is grown in the State of Wisconsin. Along with the factories farther south it experienced unusual rains during the planting season, but came through in fair shape for maturing a crop after the season became more favorable. Results in the fields were better than anticipated. The factory campaign was more than usually satisfactory.

ST. LOUIS.—After meeting with the unfavorable early weather conditions, the acreage planted to beets developed under better weather later on. The factory was able to procure ordinary acreage. Beet deliveries began October 10. The factory started slicing October 30 and finished December 28.

BLISSFIELD.—While the factory at this place was constructed this year and entered the campaign for the first time, many of its beet growers had enjoyed considerable previous experience in producing beets for the factory at Fremont, Ohio. Considerable of the acreage growing beets for this factory is in that State. Some of its growers have also grown beets for factories in other localities. It procured a fair acreage for a first campaign. The season may be rated as fairly favorable. This district produced a bountiful supply of beets. It is estimated that 6,000 acres were planted. The campaign began November 21.

EAST TAWAS.—It was decided that, unless the company operating here could secure sufficient acreage by April 15, the plant would be closed down and the beets grown for it shipped to other factories. It was decided in May, on account of small acreage contracted for, not to operate the plant during the present season. However, the farmers making contracts were encouraged to grow beets, the factory accepting them as per contract and delivering them to Bay City to be worked up. It was deemed advisable by the management to foster beet growing as much as possible with a view to making a greater effort in future. Scarcity of laborers for the fields was one of the main obstacles causing the farmers to refuse to make contracts.

NEBRASKA.

The State of Nebraska was the second to produce sugar from beets. Sixteen years ago the first factory was installed at Grand Island with a capacity of 350 tons. This was followed by one at Norfolk, in 1891, with a capacity of 350 tons, and in 1899 by still another at Leavitt of 500 tons daily capacity. These factories were all located in the eastern half of the State. During the period of their operation a part of the time has been marked by excessive drought, another by excessive rainfall, and still another by diseases affecting the beet crop. Under normal conditions sugar production in that section of the State has always proven quite satisfactory.

The factory at Norfolk was recently removed to Lamar, Colo., and there enlarged and improved. The opinion is quite generally current that the plant was removed from Norfolk on account of adverse conditions. An investigation of the facts demonstrated this to be an error. Taking the factory's record from beginning to end, it was quite satisfactory, both to the management and to the farming districts generally. But the owners of the plant possessed a large tract of land along the Arkansas River in Colorado. They had planned to establish a series of factories in this Colorado district to develop its resources. Under their policy it was preferable to remove the plant from Norfolk and place it in commission at Lamar. No doubt under the circumstances it is serving the purpose of its owners in its present

location much more satisfactorily than if it had remained at Norfolk. The farmers around Norfolk who formerly grew beets for that plant continued to produce nearly as much as before, these beets being shipped by rail to the factory at Leavitt.

It does not appear, therefore, as if conditions adverse to beet production caused the plant to be removed. There has been considerable local discussion around Norfolk regarding the establishment of a new sugar factory at that point. I look upon it as a real opportunity. A large part of the work of educating the farmers has been accomplished. With the removal of the former plant a demonstration has been made to the beet growers of their loss. A factory there now would receive sympathy and support from the farmers and others.

One of the lessons taught by Nebraska's experience in sugar production is the value of the refuse products of the factory for feeding purposes. Around all these factories are fed large flocks of sheep and herds of cattle. The experience of these factories will eventually be that of others in the United States. During the first few campaigns very little of the pulp was fed, but it grew gradually into favor, and now it may be said that its use is quite common and the pulp is generally sought after.

The plant at Leavitt increased its daily capacity for working beets from 500 to 1,100 tons. This improvement was equal to building another large plant in the State this year. Nearly all plants of ordinary capacity like the one at Leavitt are constructed in such a way that doubling the capacity simply means the introduction of machinery sufficient for that purpose. A large increase in the production of sugar from year to year in this country is brought about in this way. Such growth is not so apparent to the public but is effective in building up the beet-sugar industry.

Throughout the growing period considerable difficulty was met in procuring sufficient labor. Nebraska beet factories early began the practice of stimulating immigration of foreign labor to the beet-growing areas. The influence of this work is felt to-day in the continuous influx of this class of labor. The beet growers of other States are aware of this and are constantly calling upon Nebraska beet-growing districts for a part of this labor supply. This tends to absorb a large portion of it. Further extension of the sugar industry seems more likely to occur in the western part of the State, where irrigation is more or less developed.

GRAND ISLAND.—The American Beet Sugar Company here has a factory of 350 tons daily capacity. It was one of the original factories of the country, and has operated through many campaigns. Many of its beets are grown in the western part of the State, where irrigation is in vogue. Wet and inclement weather, followed by more or less hail, destroyed some of the plantings The season, however, improved ma-

terially later on and continued quite generally favorable throughout. A sufficient acreage was procured. This, coupled with the fact that beets returned a normal yield, gave the plant a good working campaign. The factory started October 9 and closed January 3. Many improvements were made at the factory during its interval of rest.

LEAVITT.—A factory of 500 tons was located at this place in 1899. In its equipment it is the newest and most modern of the two plants now in the State. It is located in a heavy corn-producing belt, in which stock feeding and fattening is carried on extensively. This fact is due largely to the installation of this plant by a large stock-producing concern. Its capitalization was inspired for the purpose of securing pulp without freighting it long distances. For the last two or three years the bulk of its supply of beets has come from the western part of the State—from North Platte, in Lincoln county, and McCook, in Red Willow County. The season opened with the factory possessing a larger contracted area than at any time in its history. The supply of beets gave it a campaign more extensive than any other since it was built. During the season its capacity was increased to 1,100 tons of beets daily. It is estimated that the factory contracted for nearly 15,000 acres of beets. After receiving this much it refused to take any more. The season throughout the beet-growing area was quite favorable for planting and germination of the seed. Then too much rain occurred, followed by cold weather, which interfered to some extent with cultivation and plant growth. In addition to this some damage by hail was done to the young and tender plants. The webworm was in evidence to a greater or less extent, but did not do considerable damage. Heavy rains occurred in September. This tended to retard ripening of the beets, and consequently the beginning of the campaign. The factory started October 18. The weather was quite favorable during the harvesting season.

NEW YORK.

The sugar industry has been operating to some extent in the State for a considerable time. It has had to contend with many things not present in the districts farther west. Agriculturally the State is largely devoted to the growing of crude products to supply manufacturing industries. Here we find gardening, dairying, creameries, canning, malting, preserving, and many other industries directly related to farming, particularly farming of the more intensive sort. Here the growth of the beet-sugar industry must of necessity be much slower. But there are many reasons why it should develop into a great industry. Other industries which could use the by-products of the sugar factory are already established—such, for instance, as dairying. The nearness and extent of the market is one of the greatest advantages offered to sugar production in the State of New York. The experi-

ment station through many tests of its soil conditions has proven them generally favorable. Two factories have been operated in different parts of the State for some time. The results have done much to establish conditions favorable to the sugar industry. One of these located at Binghamton, having a capacity of 400 tons, ran for several years, but was finally moved to Black Hawk, Idaho, where it could more readily secure the necessary beets. Another one of 350 tons' capacity has been operating at Lyons, N. Y. Another smaller one several years ago was established at Rome and operated for two or three campaigns. Its capacity was small, and this, coupled with difficulty in securing sufficient beets, caused it to close down, and it never reopened.

The legislature by State bounty has appropriated considerable money to foster the industry. One advantage enjoyed by these factories has been the readiness of farmers to buy the pulp from the start. It is readily sold in large quantities for 50 cents per ton and at retail for $1. When it is considered that in the production of sugar every factory turns out one-half ton of pulp for every ton of beets worked the importance of this can readily be appreciated. For instance, take a 600-ton plant, turning out 300 tons of pulp every day, worth $300. In an ordinary campaign of 100 days this would amount to $30,000. The feeders in New York are accustomed to feeding by-products from the breweries, starch factories, and malt works, and hence readily appreciated the value of beet pulp.

LYONS.—After considerable difficulty and adverse experience this factory (whose capacity has recently been increased to 600 tons of beets daily) has finally secured success in its campaigns. It had to meet and overcome the competition with the growers of special crops. For the past campaign it had contracts covering an area of 5,800 acres. Weather conditions were generally considered favorable during seeding and germination. The crop was quite satisfactory. The factory began operations October 3.

As an inducement to grow beets this company offers the farmers pulp to the extent of 50 per cent of the weight of beets delivered. This is practically giving the producers of the beets about all the pulp they produce—that is to say, the farmer sells the sugar out of his beets to the factory and retains for his stock that part which is valuable for feeding.

OHIO.

FREMONT.—For several years a factory of 350 tons capacity has been operated at this point. Its history is quite similar to that of the New York factories. It required considerable effort to educate the farmers to the point of finally producing enough beets to supply it for a campaign. In order to do this, farming districts were worked up in

different directions, generally west. The by-products of the sugar factory for feeding purposes were readily appreciated. Gradually beet growing grew in favor until now the factory is receiving an adequate supply of beets, and is one of the most successful concerns in the country. It has not only built up a sufficient beet-growing area for itself, but it has done much to stimulate beet growing in western Ohio and southeastern Michigan, where recently a factory was built at Blissfield. There is also considerable talk and negotiations among interested parties with a view to establishing a factory in western Ohio at Defiance. This is largely the result of the work of this factory. The plant was considerably improved during the year.

The season throughout was generally favorable. In the early part it was too wet with continual cold weather affecting more or less the planting and cultivation, but as a rule the season may be rated as favorable. The factory secured about 4,000 acres under contract and commenced slicing beets October 12.

OREGON.

The experiment station at Corvallis, some years ago, conducted exhaustive experiments to test the adaptation of different parts of the State to the beet-sugar industry. It was developed that in several sections conditions were naturally favorable. One factory of 350 tons capacity was established in the eastern part of the State, at Lagrande. The real drawback to further development has been the lack of transportation facilities in the valleys and other areas suited to beet growing. Farming methods as a rule are not up to standard. Any new beet-sugar enterprise in this State must necessarily educate the farmers up to the point of sustaining the sugar industry.

LAGRANDE.—At Lagrande farmers have been slow to take hold of the work of producing beets. The plant, in order to secure a sufficient supply of beets, has been compelled to work up an interest in beet growing in districts somewhat remote from the factory. However, the industry has gradually won the confidence of the agricultural producers, and the results have been much more satisfactory in recent campaigns. The work of the factory has raised the whole district to a higher plane of farming, which more nearly meets the requirements of the sugar industry. The factory secured about 4,000 acres under contract for 1905. Most of this land was carefully prepared by fall plowing. An indication of the farmers' appreciation of this institution is the general prevalence of pulp feeding. Very little of it was utilized in the beginning, but last year it was all consumed. The working out of such features as this points strongly to the final and full success of the factory. Much of the land growing sugar beets can be irrigated, if necessity requires. The unusual success attending last year's work

has done much to reinforce the confidence of the farmers. The general feeling toward beet culture is very much improved.

The spring started out a little too cold for best results, but later came better conditions, which prevailed throughout the balance of the growing season. Heavy rains fell during the spring months, supplying sufficient moisture for the early growth of the plants. A late spring frost damaged the beets to some extent, but not very seriously. Quite a number of improvements were made by the factory, among others, enlargement of the beet-storage facilities. On the whole, the season may be classed as more than ordinarily favorable. Although drought was more or less prevalent in the State, frequent showers furnished more than the usual supply of moisture. The farmers have become more adept in the work of cultivation. The factory began slicing September 18.

UTAH.

Utah was the third State to enter upon the work of sugar production from beets. In 1891 a factory of 350 tons capacity was installed at Lehi. Four other plants are now located in the State. The establishment of factories in Utah has proceeded along lines entirely different from those in other States, except possibly Colorado. Each new factory in Utah has been the result of a tendency to overproduction of beets stimulated by the work of another factory or factories. This is healthful growth. There can be no guesswork about the success of a factory when its establishment is induced by the actual demands of agriculture. Such an institution does not have to meet the obstacles of pioneer development. The farmers are educated to the point of employing the methods required, and they appreciate the advantages presented by such an institution. From the beginning the work starts off regularly and uniformly like that of old factory districts. It is simply necessary to secure acreage and machinery. The trial work of a few weeks thoroughly establishes a district in sugar production. Such conditions are ideal. Could the industry have been so built up in some of the other States no doubt factory removals would have been unheard of.

The 5 factories in Utah are divided up between two companies. The Utah Sugar Company's plant at Lehi is composed of a main plant with slicing stations at Springville, Spanish Fork, and Provo. The total capacity of this plant is 1,200 tons daily. The slicing stations simply extract the juice from the beets, mix it with limed water, and pump it down to the main plant at Lehi. These stations are located from 10 to 12 miles distant from the main plant. The one at Spanish Fork was installed last year. Piping juices is simply another method of conveying to the factory the crude product. The pipe lines were installed here in order to accommodate with transportation the avail-

able beet-growing districts, when railroad transportation facilities were either lacking or unsatisfactory. Pipe lines have also been used to some extent by one of the factories in eastern Idaho.

The Utah Sugar Company also owns another plant of 1,200 tons capacity at Garland.

The Amalgamated Sugar Company owns three plants: One at Logan of 600 tons daily capacity, one at Ogden of 400 tons, and one at Lewiston of 600 tons. Thus the combined capacity of the factories belonging to the Utah Sugar Company is 2,400 tons of beets daily, and that of the factories belonging to the Amalgamated 1,600 tons of beets daily.

Beets are produced in this State by irrigation. The beet districts are probably accommodated with better systems of irrigation than those of any other place in the country. Winter snow and later rains are the principal dependence for the water supply, and this is generally regular and abundant. The farming area is generally cut up into smaller farms than those found in other places. This produces ideal conditions, as no more beets should be planted than can be taken care of in the best manner.

The season was generally quite favorable, especially in the early part. Along the latter part of July and August an insect pest appeared, doing great damage to the crops. The designation given to this pest locally is the "white fly." Both the experiment station at Logan and the United States Department of Agriculture were called upon for expert entomologists to study the pest. The Utah Sugar Company estimates that its losses due to this cause were quite large. The ravages of the pest extended throughout the beet-growing districts of Utah and southern Idaho.

LOGAN.—A plant of 600 tons daily capacity has been operating for several seasons at this place. Since its installment the capacity of the plant has been doubled. The season opened very favorably, but the weather proved very changeable, being generally unfavorable during most of the growing period. Thirty-five hundred acres were contracted. The plant began slicing September 25. Beets were damaged more or less by drought, blight, and ravages of the "white fly." Owing to these unfavorable conditions the campaign was considerably shorter than for several years.

OGDEN.—A factory of 400 tons daily capacity has been operating at this place. Since its installation it has been very much improved. Among other things, it has added an Osmose plant to secure further extraction of sugar from molasses. As the season progressed considerable damage resulted from drought, blight, and insect pests. The factory began operations September 18, and the campaign closed December 23. The beets were not up to standard in quality and

quantity. The length of the campaign was materially below the normal.

LEWISTON.—A factory of 600 tons daily capacity was installed at this place and put in operation for the first time in 1905. It secured 3,500 acres under contract which, though ordinarily a small acreage for a plant of this kind, proved satisfactory for its first campaign. This factory is located on the northern line between Utah and Idaho on Bear River, from which stream its beet lands receive water for irrigation. Beets have been grown to some extent for some time for the factory at Logan, and more recently for the one at Garland. The conditions affecting this industry have been quite thoroughly tested.

The season opened quite favorable and continued so for some time. Blight appeared to some extent in the beets. They were also injured more or less by the ravages of the "white fly." The plant closed December 12.

LEHI.—The history of his plant has been one of steady growth and prosperity. It has gradually increased its beet-growing area and enlarged its capacity, from 350 tons at the beginning to 1,200 tons at present. During the present season, 11,500 acres were placed under contract. In order to secure further extraction of sugar a Steffens plant was installed and the Osmose plant removed to its factory at Garland. The early season was generally considered favorable to beet planting. This was followed by more or less drought and damage by insect pests, with the result that the harvest was materially below normal, both in quality and quantity. The sugar factory began its campaign October 19 and closed January 20.

GARLAND.—This large factory of 1,200 tons daily capacity is located in the upper part of the State, near Bear River, where it empties into the Great Salt Lake. Beets grown for this factory have always been of high quality, some of its growers usually taking the prize in contests of this character. Its contracted area this season was much larger than ever before, comprising 7,400 acres. The extension of the Malad Valley Railroad is increasing its beet-growing area. The season for planting and germination was most favorable. There were sufficient showers to keep the soil in the proper moist condition and sufficient sunshine to germinate the seeds. Later there was a tendency to drought. Some blight appeared among the beets, and they were also damaged to some extent by the "white fly," the resulting harvest being not as satisfactory as was anticipated in the early season.

WASHINGTON.

For the past several years considerable progress has been made in testing the conditions in this State affecting the beet-sugar industry. Many localities have been found favorable to sugar production. In some of them beets for factory use are grown under rain conditions;

others require irrigation to some extent; and still others depend on irrigation almost entirely. The development of agricultural resources in Washington is practically in its infancy. Wheat has been the principal farm product for some years. Conditions of the State are quite favorable to general cropping in those portions where adequate moisture is supplied by rain and in other districts where sufficient water has been developed for irrigation. The development of irrigation has proceeded quite rapidly in the last few years. It seems probable that, with a fuller development of the resources of the State the sugar industry will grow.

WAVERLY.—A factory of 350 tons has been operated here for some time. It was installed at the time when the agricultural resources of the district were not developed. Intensive methods of agriculture were not in vogue sufficiently to meet the demands of the sugar industry. For this reason results at this factory have not been so satisfactory as at some other places. Year by year it has been slowly establishing a permanent list of beet growers who appreciate the value of the crop more and more. It is estimated that about 4,000 acres were placed under contract to grow beets for the factory for 1905. Of this acreage about one-third was grown under the management of the factory itself.

The season started quite favorable and early. Germination was good, and a fair stand of beets was obtained throughout the district. More rain fell than usual in the early growing period, the precipitation being 4 inches in June. During July and August the tendency was to drought. The weather was not only dry, but hot, which materially affected the beet crop. The capacity of the plant was increased during the season from 350 to 500 tons. With the beginning of September more rain fell, to the material benefit of the beet crop.

WISCONSIN.

About a decade ago, when the experiment stations of the country were actively investigating conditions for sugar-beet growing in various States, Wisconsin was one of those most active. This work has been continued on quite an extensive scale ever since. In most of the States after the conditions had been determined the experimental work ceased; not so in Wisconsin. Its repeated experiments from time to time tended to check up its former work. The station has conducted feeding experiments to discover the relation of the sugar industry to other agricultural resources and interests of the State. It has carefully compiled very valuable data showing conditions in every part of the State. These have clearly pointed to a large number of districts adapted to beet-sugar production. The State has many natural advantages. It is well watered and drained; its soil is productive. As a rule, it has a good class of farmers. It is well supplied

with railroads running in every direction, furnishing cheap transportation. It also has extensive water transportation facilities. With the Mississippi on the west and the Great Lakes on the north and east, water and rail are brought into active competition with each other, insuring cheap transportation forever. Wisconsin now has 3 factories in operation and another building for 1906, while there are possibilities of a number of others. The location of its factories with their capacities are as follows: Menomonee Falls, 500 tons; Chippewa Falls, 600 tons; Janesville, 600 tons.

MENOMONEE FALLS.—A factory of 500 tons daily capacity has been operating here for several years. Through its work in developing conditions the other factories were installed. It induced the farmers of several other districts to plant beets purely for testing conditions and educating the growers. Among these places are Janesville, Madison, and Chippewa Falls. It is the policy of the management of this factory to establish other factories in the State as fast as developing conditions will warrant. Acting on this, it located a factory last year at Chippewa Falls. Others were located at Madison and Janesville by other interests. A larger acreage than usual was secured, insuring the factory's supply of beets.

The weather in the early spring was considered quite favorable. This was followed by a period of excessive rains running through June and July. These adverse conditions interfered with cultivation and the early thinning and bunching of the beets until the plants became too large for this work. This resulted in considerable loss of crops to some beet growers. A new Steffens process was installed this year. The factory began work October 21.

CHIPPEWA FALLS.—The factory operating here closed its second campaign this year. It had a contracted area for growing beets of about 4,500 acres. One of the advantages of this district is the large number of contractors growing beets on small areas. I deem this the most natural and logical method of producing beets for a factory for its first campaign. The grower is not burdened with too many details to start with. It gives him a chance to do well the work he undertakes. He can assume greater responsibilities as he becomes accustomed to the work. He is less liable to become discouraged. On these small contracts farmers take considerable pains to prepare their land properly in advance. All this preliminary work has a tendency to lessen the work of cultivation further along, and is especially helpful to beets in their early growth or tender stage.

The early season started out quite favorably. Rains were frequent and sufficient, and, where good cultivation obtained, crops were exceptionally good. The factory opened October 4, and began slicing October 14.

JANESVILLE.—The factory at this place made its second campaign in 1905. The location of a factory here was attended with considerable natural advantages. For many years this has been a tobacco-growing district. The cultivation of tobacco, like that of sugar beets, requires considerable care both in preparation of the plant bed and in rearing the plants. This involves considerable expense in the production of a crop. It is much easier for a grower accustomed to such intensive methods to take up beet growing. A large portion of the beet acreage this year was furnished by experienced tobacco growers on this old well-cultivated tobacco land. The good results in beet production have been all that was anticipated. More or less feeling has been engendered between the growers of these two crops. My own idea is that in the end both crops will be benefited, as it is not advisable to grow the same crop on the same land for several consecutive years. It will be found that growing these two crops together in rotation with other things will tend to produce the very best results with both. It keeps the land in a higher state of tilth and fertility.

It is estimated that the factory secured contracts for about 6,700 acres. The weather was a little cold in the early part of the season, but changed and continued favorable throughout the rest of the growing period of the beets. Harvesting weather was ideal. Some heavy rains fell the first part of October, after which it settled down to excellent conditions until the close of the harvest. Of the area contracted about 6,000 acres were harvested.

PRESENT DEVELOPMENT OF THE BEET-SUGAR INDUSTRY IN THE UNITED STATES.

It will be interesting at this time to consider the present development of the beet-sugar industry. I propose to offer a few tables that will tend to show its status at the present time. But tables can not indicate the influence of the industry in promoting irrigation, immigration, land settlement, the building of railroads and trolley lines, the making of other improvements, and the upbuilding of various industrial enterprises. Such results can only be appreciated by those who have visited the factory districts in Colorado, Utah, and Idaho, or in other newly settled and improved districts throughout the West.

The following table shows the number of factories with their capacities by States and the new factories under construction with their locations and capacities:

Beet-sugar factories built or building in the United States, March, 1906.

State.	Number.	Capacity.	State.	Number.	Capacity.
Factories in operation.			*Factories now building.*		
		Tons.			*Tons.*
California	6	8,400	Arizona, Glendale	1	800
Colorado	12	9,200	California:		
Idaho	3	3,000	Visalia	1	350
Illinois	1	350	Hamilton	1	1,000
Michigan	16	10,550	Colorado:		
Nebraska	2	1,450	Brush	1	600
New York	1	600	Fort Morgan	1	600
Ohio	1	400	Swink	1	1,200
Oregon	1	400	Idaho, Nampa	1	600
Utah	5	4,000	Kansas, Garden City	1	1,000
Washington	1	500	Montana, Billings	1	1,200
Wisconsin	3	1,700	Minnesota, Chaska	1	600
			Michigan, Charlevoix	1	600
Total factories in operation	52	40,550	Wisconsin, Madison	1	600
			Total factories building.	12	9,150
Factories not operating.					
California	1	1,200	Grand total for the United States	68	52,600
Michigan	3	1,700			
Total factories not operating	4	2,900			

Some of these factories work 150 days in a campaign and others but 45. Assuming that all worked under normal conditions and made average campaigns of 100 days, the 68 factories listed would work in a season 5,260,000 tons of beets; the farmers would receive for beets at the usual average price $26,300,000, and would pay for labor at least half this amount, or $13,150,000.

At a fair estimate, these factories have cost investors $52,600,000; for lands, railroads, irrigating ditches, live stock; and in other supplemental investments the beet-sugar companies have expended on a fair estimate $12,137,500, making their total investment $64,737,500. They employ on a fair estimate a working capital of $26,300,000, which added to their total permanent investment makes a total capital used in the beet-sugar industry, at the present time, of $91,037,500.

These factories use 1,052,000 tons of coal annually, valued at $3,156,000, and 526,000 tons of lime rock, valued at $1,578,000.

We can not estimate the amount paid for other crude supplies, the amounts paid to railroads for transportation, etc., nor can we begin to estimate the value of the benefit conferred on subsidiary enterprises and general mercantile business.

CONSUMPTION OF SUGAR IN 1900 COMPARED WITH THE ESTIMATED PRODUCTION IN 1906.

By means of graphic illustrations and statistical tables I will now endeavor to show the magnitude of the sugar industry of the United States, including the production of both cane and beet sugar. I will first try to portray the situation in the area west of the Mississippi. For this purpose I have made a careful estimate of the production for 1906, including the new beet-sugar factories which will be in opera-

tion and assuming that all these factories will run at their full capacities for campaigns of 100 days, assuming also that the production of cane sugar will be the same as in 1905. This estimated production of the entire area west of the Mississippi River for 1906 exceeds the estimated consumption of sugar in the same area for 1900 (the last date for which we have reliable census figures). This furnishes a striking demonstration of the rapid growth of the beet-sugar industry in this area.

It will be noted that the estimated sugar production in the territory west of the Mississippi for 1906 is about 28 per cent greater than the actual production for 1905. That this increase is within the range of possibility is evident when we consider that in this territory at least 10 new factories will begin the manufacture of beet sugar in 1906, increasing the total number to 40, and that the total capacity of all the beet-sugar factories in this area will be increased about 29 per cent. As in 1905 more than a dozen of these western factories made campaigns of more than 100 days (the average for all being 85 days), a favorable season may result in a crop of beets sufficiently large to enable a greater number of these factories to exceed the campaign limit assumed. Moreover, there may be a considerable increase in the product of cane sugar. These considerations indicate that the production for 1906 may possibly exceed the estimates used in these tables.

It would, of course, be more satisfactory to compare the estimated production of sugar for 1906 with the estimated consumption for the same year, but this seems impracticable owing to the absence of population statistics for any year later than 1900, the last census year. It has therefore been thought best to use the figures of 1900 for population and consumption of sugar. It should, of course, be borne in mind that since the year 1900 there has been a considerable increase of population in this western half of the country and a corresponding increase in consumption of sugar, so that the actual excess of production over consumption must be less than is shown by these tables.

In my report for 1901 I made a similar comparison, using the actual figures for production of that year, the result being that the total production for the whole country was 442,000,000 pounds *less* than the consumption west of the Mississippi for 1900. If the estimates I have made for 1906 are realized, the total production for the whole country (as shown on p. 79) will be 369,000,000 pounds *more* than the consumption west of the Mississippi in 1900, an increase in production of more than 810,000,000 pounds (405,000 short tons) in five years.

The States are mapped in groups from west to east, as follows:

GROUP I: Coast States—Washington, Oregon, California.

GROUP II: Idaho, Nevada, Utah, Arizona.

GROUP III: Montana, Wyoming, Colorado, New Mexico.

GROUP IV: North Dakota, South Dakota, Minnesota, Iowa, Missouri, Nebraska, Kansas, Oklahoma, Indian Territory, Texas, Arkansas, Louisiana.

Three items enter into the statistical data of each State and Territory: (1) Population; (2) consumption; and (3) estimated production based on present capacities of factories and an average of 100 days for the campaign.

Population is taken from the report of the Twelfth Census (1900).

The per capita consumption is derived by dividing the total consumption by the total population in the United States.

The amount of sugar consumed is found by adding to the amount of importations, as shown by reports of the United States Treasury Department, the amount of sugar produced in the United States.

The consumption for each State is estimated by multiplying the number of inhabitants by the per capita consumption.

Finally, all groups in the diagram are brought together to show the total production and consumption of all the States and Territories west of the Mississippi River.

In these tables, after the first the totals are carried forward so as to facilitate comparison of production and consumption of sugar not only by States and groups but by combinations of groups.

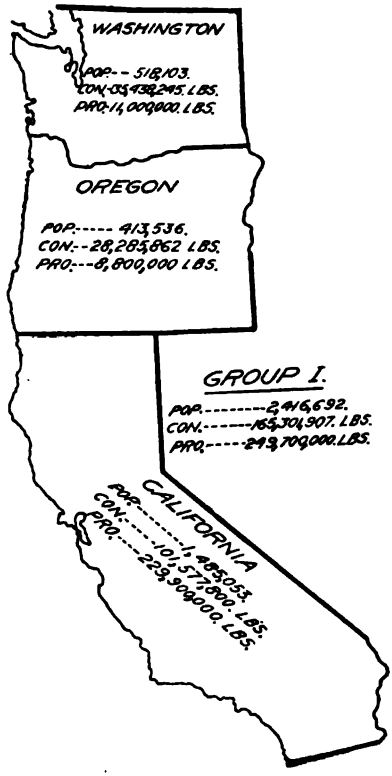

FIG. 1.—Population (1900), consumption of beet sugar (1900), and estimated production of beet sugar (1906) in the Pacific Coast States.

GROUP I.

The accompanying map for Group I (fig. 1) represents that part of our country bordering on the Pacific Ocean, each of the three States producing sugar to a greater or lesser extent. California was one of the first States in the Union to produce sugar from beets. Washington has one factory and Oregon one. In each of these States it has been reliably demonstrated that there exist proper conditions for greatly increasing the output of sugar. Especially is this true of Washington and California. There are prospects for the establishment of several new factories in the territory represented by this group. Considerable cane sugar from Hawaii has been refined annually

in California, some of it entering into consumption in the coast and inter-mountain States. Of the three States, production in California alone exceeds consumption. These figures show that the total consumption of sugar for 1900 in this group is 84,398,093 pounds less than the estimated production for 1906, provided the conditions of the estimate are realized.

GROUP I.—*Population in 1900, estimated consumption of sugar for 1900, and estimated production of beet sugar in 1906 on the assumption that all factories run at their full capacities for campaigns of 100 days.*

State.	Population in 1900.	Consumption of sugar in 1900.	Estimated production of beet sugar in 1906.
		Pounds.	*Pounds.*
California	1,485,053	101,577,800	229,900,000
Washington	518,103	35,438,245	11,000,000
Oregon	413,536	28,285,862	8,800,000
Totals	2,416,692	165,301,907	249,700,000

GROUP II.

Group II (fig. 2) represents that district which includes the States of Idaho, Nevada, and Utah. To this group is added the Territory of Arizona. The development of the beet-sugar industry has proceeded quite rapidly in most of this area during the last few years. Sugar production from beets has been carried on quite extensively in Utah for several years. The production in this State three years ago represented the entire amount for the group. Since then, two large factories have been built in Utah, four have been installed in Idaho, and a factory of large capacity is building in the Territory of Arizona. It is definitely settled that an additional factory will be built in 1906 in the State of Idaho. There is some probability that another new factory will be established in Utah and one in Nevada. The united totals for Groups I and II show that the consumption of sugar in these groups in 1900 is less by 227,903,968 pounds than the estimated production for 1906, provided, of course, the favorable conditions of the estimate are realized.

GROUP II.—*Population in 1900, consumption of sugar for 1900, and estimated production of beet sugar in 1906 on the assumption that all factories run at their full capacities for campaigns of one hundred days.*

State or Territory.	Population in 1900.	Consumption of sugar in 1900.	Estimated production of beet sugar in 1906.
		Pounds.	*Pounds.*
Idaho	161,772	11,060,280	79,200,000
Nevada	42,335	2,895,714	.....
Utah	276,749	18,929,651	88,000,000
Arizona	122,931	8,408,480	17,600,000
Totals for Group II	603,787	41,294,125	184,800,000
Totals for Group I	2,416,692	165,301,907	249,700,000
Totals for Groups I and II	3,020,479	206,596,032	434,500,000

GROUP III.

We find in Group III (fig. 3) the Rocky Mountain States—Montana, Wyoming, Colorado, and the Territory of New Mexico. Although this group represents a comparatively new section of the United States, in the last few years it has made wonderful strides in the development of the beet-sugar industry, and this has induced a general tendency to rapid development agriculturally and industrially throughout the entire district. Colorado stands at the head of the list as the heaviest producer of beet-sugar. It has 12 factories in operation, 2 more build-

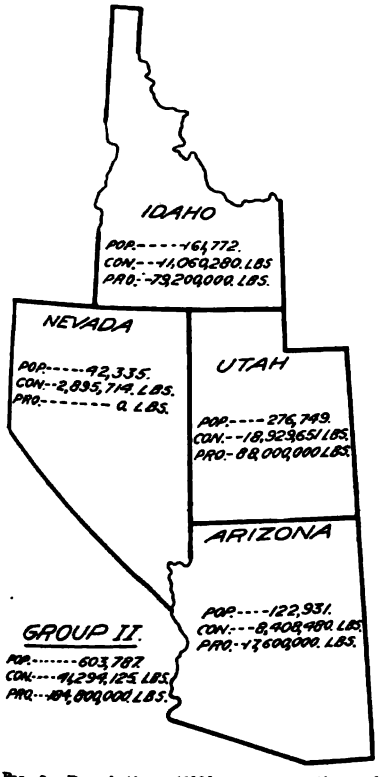

FIG. 2.—Population (1900), consumption of sugar (1900), and estimated production of beet sugar (1906) in the Great Basin States and Arizona.

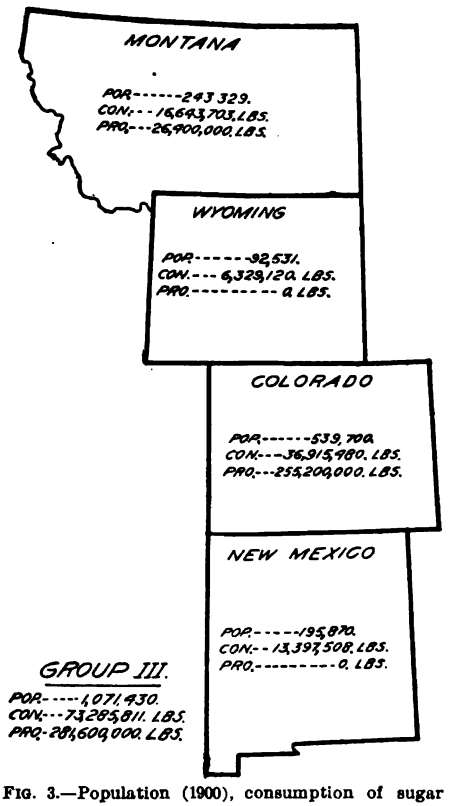

FIG. 3.—Population (1900), consumption of sugar (1900), and estimated production of beet sugar (1906) in the Rocky Mountain States and New Mexico.

ing, and several others under very active contemplation. In addition to this, Montana is entering the field. At present 1 factory is under construction and the establishment of others is receiving consideration. The conditions are quite similar to those of Colorado, and the experience of the beet-sugar industry in that State is very likely to be repeated in Montana in the very near future. A similarity of conditions in Wyoming is also influencing favorable prospects for fac-

tory installation in that State in the near future. The consumption of sugar for 1900 in this group is less by 208,314,189 pounds than the estimated production for 1906, provided all the factories run at their full capacity for campaigns of one hundred days; and the combined total production of beet-sugar in Groups I, II, and III will exceed the amount of sugar consumed in 1900 by 436,213,157 pounds.

GROUP III.—*Population in 1900, consumption of sugar for 1900, and estimated production of beet sugar in 1906 on the assumption that all factories run at their full capacities for campaigns of one hundred days.*

State or Territory.	Population in 1900.	Consumption of sugar in 1900.	Estimated production of beet sugar in 1906.
		Pounds.	*Pounds.*
Montana	243,329	16,643,703	26,400,000
Wyoming	92,531	6,329,120	.....
Colorado	539,700	36,915,480	255,200,000
New Mexico	195,870	13,397,508	.....
Totals for Group III	1,071,430	73,285,811	281,600,000
Totals for Groups I and II	3,020,479	206,596,032	434,500,000
Totals for Groups I, II, and III	4,091,909	279,881,843	716,100,000

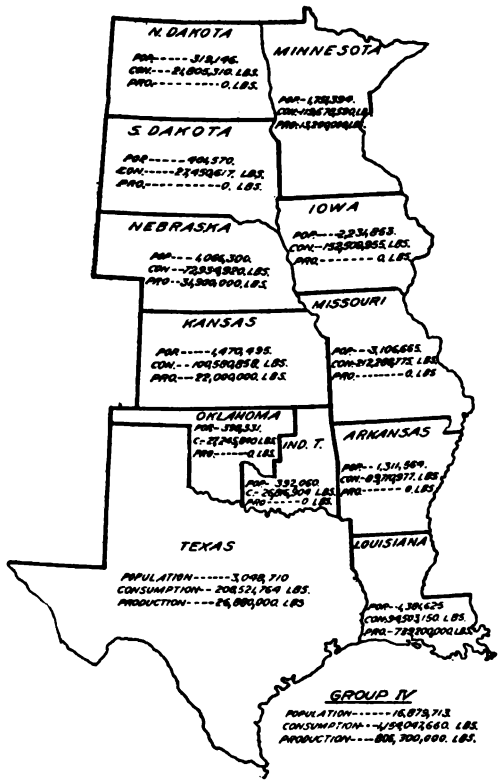

FIG. 4.—Population (1900), consumption of sugar (1900), and estimated production of sugar (1906) in the group of States and Territories lying between the Mississippi River and the Rocky Mountains.

GROUP IV.

In Group IV (fig. 4) Nebraska, with two factories (and a fair prospect for the building of others), is the leading State in the production of beet sugar. In Minnesota, where beet sugar has been produced for many years, the only factory (at St. Luis Park) was destroyed by fire in 1905. Its place will almost certainly be taken by a factory at Chaska in 1906. A large new factory at Garden City, Kans., is also a practical certainty, and its product is included in the estimate.

In Louisiana the cane-sugar factories produced last year 739,200,000 pounds, and in Texas an additional 26,880,000 pounds was produced, making a total of 766,080,000 pounds of cane sugar produced.

GROUP IV.—*Population in 1900, consumption of sugar in 1900, and estimated production of beet sugar and cane sugar in 1906.*

State or Territory.	Population in 1900.	Consumption of sugar in 1900.	Estimated production of sugar in 1906.
BEET SUGAR.		*Pounds.*	*Pounds.*
North Dakota	319,146	21,805,310	.....
South Dakota	401,570	27,450,617	.....
Minnesota	1,751,394	119,678,590	13,200,000
Iowa	2,231,853	152,509,955	.....
Missouri	3,106,665	212,288,775	.....
Nebraska	1,066,300	72,934,920	31,900,000
Kansas	1,470,495	100,580,858	22,000,000
Oklahoma	398,331	27,245,840	.....
Indian Territory	392,060	26,816,904	.....
CANE SUGAR.			
Texas	3,048,710	208,521,764	26,880,000
Louisiana	1,381,625	94,503,180	739,200,000
Arkansas	1,311,564	89,710,977	.....
Totals for Group IV (beet sugar)	16,879,713	1,154,047,660	67,100,000
Totals for Groups I-III (beet sugar)	4,091,909	279,881,843	716,100,000
Totals for Groups I-IV (beet sugar)	20,971,622	1,433,929,503	783,200,000
Total cane sugar in Louisiana and Texas	.....	.....	766,080,000
Total production of sugar for Groups I-IV	.....	.....	1,549,280,000

GROUPS I TO IV COMBINED.

The accompanying illustration (fig. 5) shows the area of Groups I to IV combined. The data included in the table given under Group IV show that the total estimated production for 1906 of beet sugar in the area west of the Mississippi will be 783,200,000 pounds; of cane sugar, 766,080,000 pounds; and the total production of sugar 1,549,280,000 pounds, or over one and one-half billions. The estimated production for 1906 in the entire area west of the Mississippi will exceed the estimated consumption for 1900 by 115,350,000 pounds (57,675 short tons).

AREA EAST OF THE MISSISSIPPI.

Beet sugar is produced in five States east of the area included in Groups I–IV. Michigan has sixteen active factories and her product of beet sugar exceeded that of California in 1903 and again in 1904. Another factory (at Charlevoix), nearly completed, will probably be engaged in production in 1906, and still another, which has been idle, is expected to resume operations. Wisconsin has three successful factories, and will certainly have four for the campaign of 1906. New York, Ohio, and Illinois each has one factory.

As the factories east of the Mississippi have always made shorter campaigns on an average than the western factories (the average for the twenty-two factories being sixty-five days in 1905), it would hardly be safe to estimate the production for 1906 on the basis adopted in the foregoing estimates. This figure is therefore reduced to seventy-five in estimating the yield of the eastern factories for 1906.

Estimated production of beet sugar east of the Mississippi River in 1906 on the assumption that all factories will run at their full capacities for campaigns of seventy-five days.

	Pounds.
Illinois	5,775,000
Michigan	193,875,000
New York	9,900,000
Wisconsin	37,950,000
Ohio	6,600,000
Total	254,100,000

FIG. 5.—Population (1900), consumption of sugar (1900), and estimated production of sugar (1906) in the entire area west of the Mississippi River.

It is easily possible that this estimated production of sugar might be exceeded in 1906; at any rate, it is a reasonable probability that it may be equaled by the actual results.

THE ENTIRE UNITED STATES.

From the figures given in the foregoing tables we can now make up a table showing the estimated total production of sugar in the United States in 1906.

Estimated total production of sugar in the United States in 1906.

	Pounds.
Beet-sugar production west of the Mississippi River	783,200,000
Beet-sugar production east of the Mississippi River	254,100,000
Total beet-sugar production	1,037,300,000
Total cane-sugar production	766,080,000
Total sugar production	1,803,380,000

As the estimated consumption of sugar west of the Mississippi in 1900 (the last census year) was 1,433,929,503 pounds, it will be seen that the total estimated production of the entire country for next year (1906) exceeds that by a little over 369,450,000 pounds or 184,725 short tons. This shows what rapid progress is being made toward supplying our entire home demand for sugar.

PROBABLE FUTURE OF THE INDUSTRY IN THE UNITED STATES.

The development of this industry during the past few years has been of a substantial and progressive character. No factories have been installed on guesses or assumptions in regard to the conditions. During the past five years factory building has extended wholly in response to developed conditions. Every new factory has been built to meet a demand induced by actual production of beets for factory use. Factories established under such conditions move along regularly and smoothly from the start. During the first season there is always to be anticipated more or less friction and drawbacks due to the adjustment of conditions. After the experience of the first campaign relations are established and the future of such a factory is assured. During these five years most of the old factories which failed to develop conditions justifying their continuance have been removed and installed in other places. Such factories removed to new places, surrounded by new environments, fostered by known and established conditions favorable to their success, are now operating satisfactorily. So we may safely assert that the adjustment period, due to immature and impractical methods of installation, is about over.

Of the States in which crops are produced by rainfall the manufacture of beet sugar has been undertaken in six: Illinois, Michigan, Minnesota, New York, Ohio, and Wisconsin. The States in which beets are grown mostly by rainfall assisted by irrigation to some extent in some of the beet districts are California, Nebraska, Oregon, and Washington—four in number. The States in which sugar beets are produced largely through irrigation supplemented by limited rainfall are Colorado, Idaho, Montana, and Utah, and one Territory, Arizona, will enter this class in 1906, making five.

It can be readily seen from the above that rainfall plays an important part in beet-sugar production. The number of factories located

in the eleven States having districts growing sugar-beets with moisture supplied mostly or exclusively by rainfall is forty-six. The total daily capacity of such factories is 31,400 tons. The number of factories in the five States growing beets where irrigation predominates is twenty-six, and their total capacity aggregates 21,200 tons.

It will be seen from the above that the number of factories and their aggregate daily capacity for production is not so great under irrigation as under rainfall. In recent years, however, the progress of the beet-sugar industry in the irrigated districts has proceeded much more rapidly and satisfactorily. This is due to the undeveloped condition of the West. It is seeking and fostering new industries. At the same time the more fully developed conditions of the East have made it necessary for the beet-sugar industry to fight for a position in a well-established system of agricultural production.

In establishing a sugar factory in the East it is almost impossible for the company to procure a large body of land of its own, at least at prices which will make the investment profitable. It has been found that it is desirable for a sugar-manufacturing company to own a certain amount of farming land, especially in the early factory work. Such land can be managed to furnish the factory a larger supply of beets from the start. The methods employed in the cultivation of the beets are also more directly under the control of the factory management. Out West a body of land can be secured more readily and at a more reasonable figure. With the establishment of the sugar factory the value of the land increases very fast. This, itself, offers a large inducement for the establishment of the factory. It takes about a year to build and equip a sugar factory. In that time an absolutely new district can be, and often is, entirely settled. With the aid of a sugar factory the settlement of such a district proceeds somewhat in a similar way to the building of what is known as a "knockdown" house—you simply bring it on the ground ready-made, put the pieces together, the whole thing is complete. The industrial growth of the community, in time and manner of development, is quite similar to that of the factory. A new district may be selected for the establishment of a sugar factory. With its foundation starts those of a town and the homes of the farming population. Roads are opened up, ditches are constructed, lands are plowed up, beets are planted, railroad facilities are introduced, and possibly trolley lines and rural free delivery. When the smoke from the furnaces pours out of the chimneys the following fall, it rolls over a well settled, improved, and prosperous community, all built and installed within the time of installation of the sugar factory. Of course, factories are more commonly located in communities already settled to a certain extent, but their establishment is always followed by marked improvements.

Prospects for further development of the industry appear very encouraging at the present time. At this time there is considerable discussion and agitation going on throughout the country in regard to the establishment of new factories. Not only is the number of new districts under investigation quite large, but there is a number of places where factories are actually building and several others where negotiations are in progress with prospects of favorable results in the near future.

ARIZONA.

PHOENIX.—Different valleys in the Territory of Arizona having ditches for irrigation or developed water resources for this purpose have been under investigation for some time to ascertain conditions for growing sugar beets and manufacturing sugar. So far as natural conditions are concerned the whole question hinges upon irrigation development. This investigation and agitation resulted in the formation of a beet-sugar manufacturing company at Phoenix, capitalized largely from eastern sources.

The location is at a small place called Glendale, about 8 miles from Phoenix. The daily capacity of the new plant is 800 tons of beets daily. During 1903 considerable work was done on this plant, the construction of the building being nearly completed. Also a considerable part of the machinery was installed. Owing to some financial difficulties, work was finally suspended and the plant passed into the hands of a receiver. Recently matters in dispute were settled and a new company organized. Contracts were made with the farmers for a supply of beets. The factory is being completed and will be ready for operation in 1906. Its first campaign will begin some time early in May. At this place beets are planted earlier than at any other place in the country. Winter rains begin along in the early part of January. Advantage is taken of this for germinating and starting the crop. Although the climate is hot, the cool evenings, the naturally favorable soil conditions, and continuous sunshine during the growing period make it possible to grow beets of superior quality throughout the valleys of Arizona.

The particular thing that inspired the building of this plant was the installation by the Government under the reclamation act of a large irrigation reservoir and ditches accommodating a large body of land. This was one of the first established by the Government, is a magnificent piece of work, and will be the first of the Government reservoirs completed in the United States.

CALIFORNIA.

California was the first State in the Union to go into the beet-sugar industry extensively. In the early nineties the wave of financial depression existing throughout the country affected the producers on the Pacific coast probably more seriously than others farther east and better located in regard to markets. The time required for shipping crude products from California to the East is especially discouraging to producers of perishable crops. It was but natural that California should begin to investigate carefully the methods for diversifying agricultural production. This led to the establishment of canneries, dairies, creameries, poultry farms, and sugar factories. The original purpose was to grow sugar beets with natural moisture. Sugar production was quite spasmodic at first. Unfortunately, in the early history of sugar production in California the State experienced a long period of drought, and as the sugar industry was one of the least understood it was the most affected. The results have been favorable to the industry rather than harmful. They caused more conservative action in factory building and inspired more energy in developing conditions to meet the demands of the factories already installed. The seasonal conditions of valleys were studied to find the best time for planting beets. The development of water supply for irrigation also became a burning question. This led to the development of artesian wells, some of them flowing and others requiring the use of pumps.

During the past few years considerable agitation and negotiation has occurred at different points touching the installation of new factories. The following places have been under consideration:

CHICO.—Chico is located in the Sacramento Valley in Butte County, about 100 miles north of San Francisco. This valley has been investigated throughout its length and breadth for some time to ascertain its adaptation to the beet-sugar industry. Conditions favorable for this purpose have been pretty thoroughly demonstrated. In my last report I noted the strong probability that Colusa would secure a sugar factory, but this agitation culminated in a decision to locate a large factory at Chico, near Colusa. Recently the Alta Beet Sugar Company, with a capitalization of $2,000,000, decided to build a plant of 1,000 tons daily capacity here. The operating company has purchased 8,500 acres of land. The factory is to be located about 12 or 14 miles from Chico in a new district. Its location is to be known as Hamilton. Engineers are now laying out the site. A town will be started with 150 new houses. The lands will be put under cultivation, and everything will be in readiness for the campaign of 1906. Beets will be grown by irrigation. The company has a ditch of its own extending about 7 miles, the water coming from the Sacramento River.

The Sacramento Valley has been under investigation during this season and last. Considerable agitation has occurred throughout its length. This was induced by the united effort of the business organization representing all the leading towns in the valley. In order to get some authentic record of the results of beet growing, I have procured in this valley a statement showing results at Colusa in 1896. The beets tested were grown by 84 farmers. They were of desirable size. The yield averaged about 17 tons to the acre. The beets averaged 15 per cent in sugar content and over 80 in coefficient of purity. Considering that these experiments were made by farmers, I regard this showing for Sacramento Valley as highly encouraging.

FRESNO.—This place has been under discussion to a considerable extent during the early part of this season. The chamber of commerce for the county appointed committees to solicit acreage from the farmers. A general interest was manifested. Agents of the Santa Fe Railroad took an active part in the discussion. Negotiations have been under headway for some time. Indications point to the location of a sugar factory at this point some time in the near future. It is one of the best-developed districts of California. Market gardening is carried on to a considerable extent; also the production of small fruits. It is especially noted as a grape center.

VISALIA.—A company known as the Los Angeles Sugar Company for some time exploited conditions in the Antelope Valley with a view to establishing one or more sugar factories. This company changed its name to the Pacific Sugar Company, contracted for 3,000 acres of beets, and is constructing a plant at Visalia with 350 tons' daily capacity. A part of the machinery composing the equipment of this plant comes from St. Louis Park, Minn. The company owns a site of 40 acres near the town, which is reached by the Southern Pacific Railroad and is accessible to the Santa Fe Railroad. The 1st day of January, 1905, the factory was about half completed and 90 per cent of the machinery on the ground. The plant will be in readiness for the campaign which begins about August, 1906.

In the vicinity it is estimated that 100,000 acres of good beet land can be found. Beet planting in the district begins about January 1, and can be continued up to April 1. Early beets are grown without irrigation; but the later plantings require it. The soil is a fine sandy loam, with a little tendency to alkali. Visalia is about 150 miles north of Los Angeles, in Tulare County.

Below is inserted a report from Prof. G. W. Shaw, College of Agriculture, Berkeley, Cal., showing the high quality of beets grown in the district tributary to this new factory:

Referring to your favor of the 19th instant, relative to the analysis of beets grown at Reedley in 1905, I beg to say that I analyzed two samples of beets brought to me by C. L. Sea-

graves, a representative of the Santa Fe Railroad, the results of said analysis being as follows:

No. 1. Brix, 24.037; sugar in juice, 21 per cent; apparent purity, 87½; average weight, 625 grams.

No. 2. Brix, 25.237; sugar in juice, 22.60; apparent purity, 85.8.

You will note that these beets are exceedingly high in both sugar and purity, and are of fair weight. As to the individuals who grew these beets I have no knowledge.

Yours, very truly,

G. W. SHAW.

COLORADO.

Throughout my reports for the last four or five years I have discussed pretty generally and thoroughly conditions adapted to the beet-sugar industry in this State. This industry has materially changed and helped the whole agricultural status of the State. Probably the changes are more noticeable in this State than in any other. This is due to the fact that, when started, Colorado's agricultural resources were practically in their infancy. For this reason results could be more readily ascertained. The sugar factories in Colorado are constantly under investigation by committees from neighboring States representing associations, chambers of commerce, farmers' organizations, and the like. It is quite likely that the industrial development of Colorado will be duplicated to some extent in neighboring commonwealths. This is already true of Idaho and to some extent of Montana, with strong probability that it may be even more fully realized in Wyoming. In Colorado new lands have been reclaimed and large modern plants installed. These have been improved from year to year and additional and supplemental facilities have been added. Though but a few years have intervened, one of the strongest of farmers' organizations in the State is that of the beet growers, with county associations from which a State organization is formed, holding annual meetings. Two new factories entered the campaign last year; others are building, and quite a number are in prospect.

BRUSH.—In earlier reports I discussed conditions around this place and called attention to the strong probability of the installation of a sugar factory. During the season of 1905 a factory was located here by the Great Western Sugar Company. The plant has 600 tons' daily capacity. The farmers in this vicinity are now experienced in sugar-beet production. For several seasons they have been growing beets for other factories. The factory now under construction will be in readiness for the campaign of 1906.

Brush is in the eastern part of Morgan County and the northeastern part of the State, and is located on the Burlington and Missouri River Railroad. Its farming lands are irrigated from the South Platte River. In anticipation of establishing a factory at this place the beet-sugar company secured the growing of 1,500 acres of beets there in 1905 and contracts covering 3,500 acres for 1906.

COLORADO SPRINGS.—For some time investigation has been made of Fountain Valley, lying southeast of Colorado Springs, distant about 15 miles. This district is well adapted naturally to beet production. Recently a tract of 30,000 acres was purchased. It is to be watered from two storage reservoirs covering about 400 acres each, 60 feet deep, and furnishing an abundant supply of water. The plan contemplates the erection of a sugar factory at Fountain, on the railroad, in the center of the district.

FORT MORGAN.—The Great Western Sugar Company has established a factory at this place with 600 tons daily capacity. Farmers in the district have been growing beets for two or three years for other factories in the vicinity belonging to the same company. The pioneer work of the industry has been done. Sugar-beet growing and the benefits of the industry are very well appreciated in the district. The industry starts off under conditions favorable to its success. The factory will be in readiness for the campaign of 1906. About 1,500 acres of beets were grown for the campaign this year. At the same time contracts were secured for 3,500 acres for 1906.

Fort Morgan is about 10 miles west from Brush, in the center of Morgan County, in the northeastern part of the State. The beet lands are irrigated from South Platte River. It is on the Burlington and Missouri River Railroad.

LAS ANIMAS.—Quite a large acreage of beets has been grown around this place for several years and shipped to Rocky Ford. Gradually this acreage has been increasing until conditions have been sufficiently developed to sustain a sugar factory. For some time business men and leading farmers in the vicinity of Las Animas have been agitating factory establishment. On two or three occasions it was quite definitely announced that the factory was assured. The owners of the one at Rocky Ford naturally feel an interest in the legitimate result of their development work. They have extended considerable encouragement to Las Animas. Recently it is announced that this company made a proposition to the Commercial Club of Las Animas that a 600-ton plant would be installed here provided contracts for 2,500 acres could be procured for 1906 and 5,000 for 1907. Committees have completed this work and it is announced that the American Beet Sugar Company will build a factory of 600 tons daily capacity in accordance with this proposition.

Las Animas is located in Benton County, in the southeastern part of the State, on the Santa Fe Railroad, about midway between Rocky Ford and Lamar, at each of which the American Beet Sugar Company already has a factory. Lands growing beets in this vicinity are irrigated from the Arkansas River.

I clip from the Denver Post, of January 19, 1906, the following:

A formal contract has been drawn between a committee and citizens of Las Animas and Frederick Weitzer, manager of the American Beet Sugar Company, whereby, in consideration of 2,500 acres of beets for the year 1906 and 5,000 acres for the years 1907, 1908, and 1909, to be grown in the vicinity of Las Animas, the American Beet Sugar Company agrees to construct a 600-ton beet-sugar factory here for the 1907 crop and to add a railroad spur from Las Animas east and west for a distance of about 10 miles each way. These spurs are to be connected with similar spurs built out of Lamar and Rocky Ford, thus forming a through line. All is to be completed by 1907. The American Beet Sugar Company is to provide a large bond to insure the construction of the road and fulfillment of its contract.

SWINK.—Plans and contracts have been made for a factory at Swink, which is located 5 miles east of Rocky Ford. It will accommodate a large beet-growing district north and east of that factory which has been growing beets more or less for it but not to the extent of its capabilities on account of the difficulty of delivery. The factory located at Swink is to have 1,000 tons daily capacity. It is established by the same interests owning the factory at Holly.

A railroad is to be built from Holly to Swink Station, a distance of 85 miles, in order to accommodate its work and its beet-growing district. Contracts for 11,000 acres of beets have been signed. This guarantees the plant an abundant supply of beets during its first campaign. It is to be completed in time to work up the 1906 crop. As in other beet-growing districts in the southern part of the State, water for irrigation comes from the Arkansas River.

OTHER PLACES.—Colorado has proved a very fertile field for investigation and extension of the beet-sugar industry. In districts throughout the State located in fertile valleys whose agricultural resources have been investigated, if possessing sufficient area to maintain a sugar factory, its installation is looked upon as the one thing necessary. Results repeated so many different times at different places point to sugar production as the main feature in all plans for settling and improving a district. Farmers and business men are drawn together in an organized attempt to unite all interests in a move to secure a sugar factory. Pledges are secured from the farmers covering sufficient beet-growing acreage to sustain a factory. Negotiations and agitation proceed to the accomplishment of this end. In most of these places beets have been grown for factories at other places and the farmers informed regarding the conditions and requirements of beet culture. At quite a number of places in the State such campaigns are now being conducted. Among those often and favorably considered, in addition to those mentioned, are Julesburg, Delta, Montrose, Durango, Olathe, Glenwood, Erie, Boulder, and Pueblo.

IDAHO.

Idaho is one of the States recently developing considerable interest in beet-sugar production. For some time many of her valleys available for intensive agricultural development have been under investigation. This investigation culminated in the last three years in the establishment of four large factories. Beets grown in the State are of an unusually high quality, and the yields are good. As fast as development shall proceed and conditions warrant, several other factories will be installed in the State. A factory is now building at Nampa with 600 tons capacity. This belongs to the Idaho Sugar Company, the same as the ones at Sugar, Idaho Falls, and Blackfoot.

PAYETTE.—Contracts were secured at this place for 3,500 acres of beets for the 600-ton factory to be built at this place by the Idaho Sugar Company. This factory was to be in operation for the campaign of 1906. Afterwards arrangements were made with the company to deliver the beets grown for 1906 to the factory at Nampa, the sugar company entering into a contract and bond to build a factory at Payette in 1906 to operate in the campaign of 1907.

Several other places are under serious discussion as regards the location of a factory.

ILLINOIS.

From time to time we hear considerable discussion about the establishment of factories in the lake region of Illinois, especially in the vicinity of Chicago. This agitation is induced by the superior commercial facilities offered for industries of all kind in that section of the State. By thorough experimentation it has been found that the soil in the northern part of the State is well adapted to beet production. During the past season a factory of 400 tons daily capacity was installed at Riverdale. Plans are maturing for the introduction of one or two others in the vicinity of Chicago.

GENESEO.—This town is located on the Rock Island Railroad about 20 miles east from Davenport and on the Mississippi River. It is in one of the old, well-established farming districts of the State. The soil yields 60 to 100 bushels of corn per acre and other things accordingly. Most of the corn produced is fed to stock in the community. Good farm lands are generally valued at $150 per acre. This district took up the agitation for establishing a beet-sugar industry. Public meetings were held, contracts were secured for a large acreage, negotiations were entered into with capitalists, promoters, and others with a view to capitalizing the project. It was finally concluded by all those interested that the season had progressed too far to plant beets and build a factory for the campaign of 1905. It was decided to plant a number of plats to sugar beets throughout the neighborhood with a view to more nearly ascertaining natural conditions. As in nearly all

other experiments of the kind with no directing head insisting on details, the results of these experiments were generally unsatisfactory. This is an old story. Such experiments indicate nothing. I have seen so much of this reckless work of experimentation, which means nothing but disappointment unless followed out in the most careful manner, that I give the results but little weight as evidence. It is proposed to conduct further experiments at this place to ascertain more definitely natural conditions and keep in touch with outside interests tending to further the enterprise. To the investigation of this place I gave considerable time and attention. I am thoroughly convinced that the farming district would eventually prove it a superb location for a beet-sugar factory. The company would have to depend entirely upon sugar making, as there could be no profit from investment in land for a rise in value.

IOWA.

Considerable agitation tending to the establishment of sugar factories occurred in the State during the year. By experimentation, favorable conditions have been ascertained. As a rule the beets grown are of sufficiently good quality to meet the requirements of a sugar factory. In growing sugar beets it especially excels in two things: (1) Its regularity of crop production; (2) its yield. The real difficulty in promoting the beet-sugar industry in Iowa and many other States in the Mississippi Valley and farther east arises from the farmers' disinclination to grow the crop. This feeling in Iowa would probably change with the installation of a sugar factory. Good yields would overcome the farmers' inertia. On account of the adaptability of the soil of the State to sugar-beet production, its railroad facilities, and proximity to good markets, I regard it as very favorable territory for sugar production, and I find that some of the leading beet-sugar producers of the country entertain the same views.

The places now under discussion and investigation are Columbus Junction, Des Moines, Muscatine, Waterloo, and Waverly. During 1905 considerable agitation and discussion occurred at these places.

KANSAS.

Conditions favorable to beet-sugar production have been under investigation for several years in the eastern half of Kansas, or that portion usually considered within the corn belt. Considerable interest has been evolved at times at different places, but none of the prospects have materialized into actual sugar factories. The operations of the factories in eastern Colorado along the Arkansas River have stirred up considerable interest in the western part of Kansas. Conditions here are somewhat similar to those in eastern Colorado. The rainfall is light, but for the last two years beets of good quality and

yield have been grown for the Colorado factories. In order to encourage this industry the legislature of the State passed a law five years ago offering a bounty of $1 per ton for all beets grown in the State. This has had a tendency to stimulate the industry in the extreme western part of the State, where irrigation from the Arkansas River is developing to a considerable extent, and notably in the vicinity of Lakin and Garden City. This is also true around Arkansas City, at a point near the southern boundary, where the river goes out of the State. The interest developed in the western portion is largely confined to Finney and Kearney counties, of which Garden City and Lakin are the county seats, the Arkansas River passing through both counties from west to east. The American Beet Sugar Company, having factories at Rocky Ford and Lamar, has developed this territory for growing sugar beets for those factories.

GARDEN CITY.—It has been announced for some time that Colorado sugar-producing interests would install a factory at this place as soon as irrigation facilities were sufficiently developed and beet production should develop to the point of sustaining a factory. During this season some of the leading beet-sugar capitalists of Colorado expended a large sum for land near Garden City. They also bought up, improved, and extended irrigating ditches, reinforcing them with new pumping plants, and invested considerable money in several enterprises incidental to sugar production. Finally, plans were adopted for erecting a sugar factory at this point of 600 tons daily capacity. Material was purchased and contracts let for the installation of this concern for the campaign of 1906. The United States Government has established at this point a pumping irrigation plant, which will materially aid in the development of the district. Farmers are to receive a flat price of $5 per ton for beets delivered by wagon or loaded on cars at station.

As indicating the purpose of those investing in sugar factories, lands, etc., near Garden City, I clip from the Kansas City Journal of December 20, 1905, the following:

"We have already planted $500,000 in Kansas land near Garden City," said Mr. Hamlin, "and will put another $1,000,000 in within the next twelve months. We hope to have the sugar factory at Garden City completed in time for next year's beet crop. The company contemplates the construction of four more sugar factories in the valley as the industry develops. Most of the beets next year will be raised on bottom land, but the uplands will be under irrigation within a couple of years. Experts say that the water can be conserved better where ground is irrigated and that the soil is well adapted for the culture of sugar beets. Our company will not depend in any way on the Government irrigation plant at Garden City. We have a plant of our own; in fact, we own three ditches out there now and an interest in the fourth one. We will irrigate on our own hook. We expect to put in a big pumping plant at Dodge City for one of the ditches. We are contracting now with farmers for sugar beets for next year. We expect to get at least 40,000 tons from the country around Garden City next year. This will be a good start."

In order to ascertain the facts with reference to this project, I solicited and obtained the following special report from Chas. A.

Loucks, Lakin, Kans. He was prominent as a member of the local committee to encourage the establishment of this industry in the district:

DEAR SIR: The United States Sugar and Land Company are at present erecting a 600-ton factory at Garden City, Kans., the contract for the building having been let, and surveyors are now at work on the site. These people have purchased, as nearly as I can ascertain, some 40,000 acres of land in the Arkansas Valley, lying between Lakin and the town of Garden City. They have purchased two systems of canals in this county, and are making extensive improvements. They give us their assurance that there will be several other factories erected in the valley just as fast as a sufficient amount of beets is grown to warrant it.

Yours, very truly, C. A. LOUCKS.

OTHER PLACES.—It is announced by those interested in establishing the plant at Garden City that four other factories will be built in the vicinity of the Arkansas River in western Kansas as soon as developed conditions shall warrant. The town of Lakin has grown beets to a considerable extent and has demonstrated conditions quite favorable to this industry. It is likely that this will be the seat of a sugar factory in 1907, and several others will follow in the near future in this district. Deerfield is another place where a factory will very likely be installed.

MINNESOTA.

During the season a large number of places in different parts of the State of Minnesota have been investigated to ascertain conditions adapted to the beet-sugar industry. All these have been found quite favorable for the purpose. A factory has been in operation at St. Louis Park near Minneapolis for a number of years. For this factory beets have been grown in an area extending from it each way for 100 miles. This has disclosed in a practical way conditions for producing sugar beets in the southeastern half of the State. During the season the factory at St. Louis Park was burned, resulting in a total loss. This stimulated the endeavor of other places to secure the site of its rebuilding. Considerable discussion and agitation have occurred in the southeastern part of the State during the year. For many reasons this district offers excellent opportunities for the establishment of two or three sugar factories. The one that has been operated here has done the pioneer work and has built up and established conditions favorable to the industry. It will not be necessary for a new factory to go over the same ground. The management of the old factory accomplished this work at considerable trouble and expense. To secure sufficient beets it was necessary to take contracts at places too far distant. Originally considerable beets were grown for this factory in Iowa at points 250 miles distant. Gradually the factory was able to recede from these distant areas as it built up a supporting area of beet growing nearer home. Beet cropping has grown very much in favor of late, and the factory builder who succeeds in obtaining a

location in this district will fall heir to the benefits of this work so necessary to the successful operation of every sugar factory.

Among the places discussed this season with a view to installing the industry in the State are the following:

CHASKA.—Chaska is one of the places whose business men and farmers have made strenuous efforts during the season to interest capital in the establishment of a sugar factory, with the result that the Carver County Sugar Company was organized. This place is well located to receive the benefit of the development work of the factory at St. Louis Park, recently burned, covering the last six years. It is 20 miles south of the location of this original factory and more nearly in the center of the district that has been growing beets for it. It is well accommodated with railroads connecting with other railroads which thoroughly cover the farming district for 50 miles in every direction. This is an old, well-established, and well-developed farming district. Considering the work that has been accomplished in beet growing in this part of the State and the favor in which it is held by farmers generally, there is every reason to believe that this factory will be a success from the start.

FARIBAULT.—The Commercial Club at this place has made energetic endeavors to secure the location of a sugar factory at this point. Committees were appointed to solicit acreage from farmers, the contracts being made to cover five years. These efforts were inspired by negotiations with prominent sugar-producing interests of Michigan. The acreage was procured, but for some reason the first project failed to materialize. Following this, another offer of capitalization was made on conditions that sufficient acreage be pledged and a $20,000 bonus granted. The plans provide for a 600-ton plant.

Faribault is situated in Rice County, in the southeastern part of the State. It is in a splendid agricultural district. It produces corn, potatoes, small grains, and live stock. The farming district has produced sugar beets to greater or less extent for the factory at Minneapolis. It has railroads radiating from it through its farming areas in five different directions. It is well located and would no doubt sustain the beet-sugar industry admirably. Prospects appear very encouraging for the location of a sugar factory at this place to be in operation in 1906.

GLENCOE.—This place has been under consideration by several parties during 1905. General conditions for growing beets and producing sugar are conceded to be favorable. A sugar factory is possible at this point some time in the near future.

MICHIGAN.

Michigan has more sugar factories than any other State in the Union. Factory building proceeded faster than conditions would warrant; that is to say, some places were congested beyond the capacity of farming districts to supply the beets. Other factories were placed in districts where the farmers have shown a disinclination to grow beets. These errors have been corrected by the removal of some of the plants to other places better able or more willing to supply their wants. In all 24 factories have been built. During this year a factory of 600 tons' capacity was installed at Blissfield, near the southeastern corner of the State. It receives considerable beets grown in Ohio. Beet growing has become more or less popular in the northwestern part of that State.

CHARLEVOIX.—Three years ago a company started to erect a factory of 350 tons capacity in this place. After expending about $250,000 the management experienced some financial difficulties, and work was stopped. The building was nearly completed, and considerable of the machinery was installed. This property passed into the hands of a new company during the present season. It is announced that this company will complete the plant, secure contracts for growing beets, and operate in the campaign of 1906. Beets have been grown in the vicinity of this place to a considerable extent from the year in which construction of this factory began. These beets have been delivered to other factories in the State. Their production has contributed to the general education of the farming district in the methods and benefits pertaining to the crop.

MONTANA.

Like Wyoming and Idaho this State has many natural resources for sustaining the beet-sugar industry; it is new and undeveloped and prepared to embrace at once any opportunity to forward its industrial growth. It is lacking in transportation and irrigation development. It has several large water courses draining the mountain areas. These gather the water from snow and rain and distribute large volumes to the valleys. The opportunities for storage presented by these water courses and mountains is attracting the attention of the Government Reclamation Service. The State's general conditions as regards the sugar industry are quite similar to those of Idaho, Wyoming, and Colorado. The soil also is similar in character.

There are plans on foot to install beet-sugar factories in a number of valleys in Montana. These have been maturing during the last few years. They necessarily move slowly from the fact that they involve so much other improvement necessary to the sugar industry, such as extension of railroads, irrigating ditches, settlements, etc.

BILLINGS.—A factory of 1,200 tons capacity is building at Billings. This is in the southern part of the State, about midway between the eastern and western boundaries of the State, on the Northern Pacific Railroad. The agricultural lands are watered from Yellowstone River. A new ditch has just been completed covering a large body of new cultivable lands. The district is considerably advanced for a new section. Prospects for the future of the sugar factory appear bright.

BOZEMAN.—Bozeman is the seat of the agricultural college and experiment station. The district has been on the eve of locating a factory for some time. This district, known as Gallatin Valley, has especially been under investigation by experienced parties from Utah, who look upon it with much favor. Considerable rivalry has developed between this place and two other favorable points, known as Central Park and Manhattan.

Contracts with the farmers covering sufficient acreage to sustain a factory have been procured. These extend over a period of three years. Upon these as a basis local interests are endeavoring to negotiate with capitalists and are receiving considerable encouragement.

HAMILTON.—This place is located in Bitter Root Valley. Considerable agitation has been kept up for some time under the direction of the business men's club at that point. It is now arranging contracts to procure 5,000 acres as the result of a proposition from capitalists to build a factory at this point if this acreage can be procured. Local capital has been pledged to the extent of $200,000. The plan under contemplation provides for a 600-ton plant. The agricultural conditions for growing sugar beets throughout the district have been tested in many ways. These are found quite favorable for the industry. The results of investigations made by the experiment station at Bozeman and the sugar factories of Utah and Colorado are especially favorable to sugar production.

KALISPELL.—This place is located in the Flathead Valley. Those locally interested have been attracted to the beet-sugar industry, and the district has received considerable attention from persons engaged in beet-sugar production. Both the companies operating in Utah have investigated conditions around this place quite carefully, and both have been favorably impressed. It is currently reported that both these companies have made propositions to build factories at this point provided sufficient acreage is placed under contract and at their disposal.

OTHER PLACES.—At several other places the people have gone into the subject more or less definitely with prospects somewhat encouraging. Among them are to be noted Chinook, Laurel, Missoula, Dillon, and Great Falls. The latter place is in the vicinity of what is known as the Sun River Government project for irrigation which, with the

Conrad Canals already operating, gives the district sufficient water to irrigate a large body of land. This place has been offered a factory as soon as it is in a condition to produce 5,000 acres of beets.

NEBRASKA

For several years three plants have been operated in the eastern portion of Nebraska, where beets are grown under rain conditions. While there has been more or less discussion with reference to the establishment of other factories in the eastern part of the State, none of it has apparently been serious enough to produce results. As in Kansas, new projects appear to seek the drier western section of the State, little developed but possessing irrigation resources and capable of considerable intensive agriculture if water is applied. The factories at both Leavitt and Grand Island at present receive more beets from the western part of the State than from their immediate vicinities.

NORFOLK.—Considerable discussion and agitation have occurred during the past season with reference to Norfolk. When the American Beet Sugar Company removed its factory from this place to Lamar, the building and 240 acres of land were returned to the citizens who gave it for this particular purpose. Those locally interested are anxious to see the sugar industry reinstalled. In the absence of the factory the people of this place have learned to appreciate the great benefits they have lost. More beets were grown in the district around Norfolk during this season than usual. The beets were delivered to the factory at Leavitt, a considerable distance away.

Among others who have been brought to a realization of losses sustained in the removal of a factory is the management of the Union Pacific Railroad. This company has united its influence with that of business men and leading farmers of the district to induce some other company to equip the building with sugar-manufacturing machinery and start sugar production again, offering as an inducement the plant as it stands for this purpose. This proposition has been under consideration by several parties interested in beet-sugar production. The inducements are certainly very encouraging. The fact that this locality has been under development so long and that the old factory has accomplished so much in developing resources of beet-sugar production at this point should receive great consideration. The further fact that the farming community and business element have been able to measure the benefits of such an institution by being deprived of them for a time will be another strong feature in its favor. I am convinced that if the sugar factory should start in operation again at this place it would realize an appreciation on the part of the public similar to that realized by the plant at Grand Junction, Colo., after it had closed down for a couple of years. This is an expensive kind of schooling, but very effective.

NORTH PLATTE.—The district around North Platte has been worked up until annually it produces for factories farther east in the State about 4,000 acres of beets. This amount of land under normal conditions would furnish Grand Island more beets than it ever secured for a single campaign, or would give the factory at Leavitt an ordinary campaign.

It was announced in 1904 that the Standard Beet-Sugar Company of Leavitt had proposed to business and farming interests of North Platte that, if a large acreage of beets were grown for the factory at Leavitt during the years of 1904 and 1905 and contracts with farmers procured for 6,000 acres for three years, beginning with 1906, a factory would be constructed at this place by the people interested in that company. These conditions have been complied with, and it is announced that the Standard Beet Sugar Company has arranged its plans and ordered machinery to establish a factory at this place to be ready for the campaign of 1906. The new company is to be known as the Overland Sugar Company, to be located at North Platte, or some place near, in Lincoln County. All these lands in this district under irrigation have given excellent results in beet growing for several years both in quality and yield of beets. Water for irrigation here comes from the Platte River.

In order to obtain as correct information as possible with reference to the establishment of a beet-sugar factory at this place in 1906, I wrote Mr. James Scilley, of North Platte, who makes report with reference to the new factory and prevalent conditions during the season as follows:

Mr. Leavitt expects to build a 650-ton factory in the vicinity of North Platte this spring. He expects to have it ready to work up the 1906 crop. There are 8,000 acres of beets signed up for three years for the new factory. We have not had a very successful year this year on account of adverse weather conditions, which has cut the tonnage some and also caused the beets to be lower in sugar.

Our acreage has largely increased, and I think we will have 12,000 acres in this valley the coming year. We have grown 1,000 acres in Scotts Bluff County this year, which have made an average of 15 tons per acre, some of them yielding as much as 28 tons per acre.

On the whole, the industry is in a very healthy condition in this territory.

OTHER PLACES.—There are several other places out in western Nebraska having conditions quite similar to those at North Platte, that have been considered quite seriously with a view to establishing sugar factories. As at North Platte, beets have been grown in the vicinity of these places for some time, conditions have been thoroughly tested, and the benefit of beet crops are thoroughly appreciated by all concerned. Scarcity of labor and the undeveloped condition of the districts are the main drawbacks. Sutherland, in the western part of Lincoln county, in which North Platte is located, has agricultural lands irrigated from the Platte River. McCook, the county seat of Red Willow county, and Culbertson, in the eastern part of Hitchcock

county, are places around which considerable beets are grown annually. These beets are of high quality, and, with sufficient water, the land returns a good yield and beets of high sugar content and purity. Irrigation in both these districts is conducted from the Republican River.

NEW MEXICO.

In the arid section that has been investigated for conditions favorable to the beet-sugar industry is the Territory of New Mexico. At different times several places have been under investigation with the result that natural conditions are found favorable wherever sufficient water can be secured. A small plant some years ago was built at Carlsbad on the Pecos River. This operated for two or three years, and then was discontinued for a year or two until a more satisfactory area of land devoted to beet growing could be developed. During this interval the factory burned down. Among other drawbacks to its success, it was too small. Also with the facilities for irrigation in use at that time under the heavy evaporation of a dry season, the waters were too saline for good results with the beet crop.

About 75 miles north of this place is Roswell, in the center of a very productive fruit district. Irrigation here is largely from artesian wells and conditions are all that could be desired for producing sugar beets. The business interests of this place during this season received a proposition from outside parties interested in sugar production, offering to build a plant of 1,000 tons daily capacity provided contracts could be secured for a sufficient acreage to grow the sugar beets. Experiments have been conducted during the year to test conditions and the matter is under consideration with strong possibilities that a plant will be erected here in the near future.

OHIO.

Many places in the northern part of the State have been investigated with a view to building sugar factories. Conditions agriculturally and commercially have been found generally favorable. The State has maintained one factory at Fremont for several years. Like other factories established in the older and more settled portions of the country where productive and commercial interests are well established and developed, the Fremont factory had a hard struggle at first to maintain itself. Gradually it has built up its resources until it is one of the most successful concerns of the kind in the United States. To secure sufficient beets it necessarily had to reach out to a considerable distance from its base, gradually contracting its beet area as beet growing increased nearer home. Its beet district in the northwestern corner of the State developed more rapidly than in other parts. This was caused by the proximity of two or three factories in Michigan for which beets were grown as well as for the one at Fremont.

DEFIANCE.—The agricultural district of which Defiance is the center grew beets to a considerable extent for these other factories. For some time it has been apparent that beets could be grown nearer home for the factory at Fremont. This has led the management of the Continental Beet Sugar Company of Fremont to propose the installation of a factory at Defiance. It made a proposition to those locally interested at this place to build a 500-ton plant provided contracts for 5,000 acres of beets could be secured. Business clubs and organizations of the place took the matter under consideration, committees from these procured the acreage, and the company has given assurance that it will build a plant in time for the campaign of 1906.

TOLEDO.—There has been more or less discussion and agitation in behalf of the establishment of a beet-sugar factory at this place. In order to obtain facts, I wrote the secretary of the Business Men's Chamber of Commerce Company and received the following reply.

DEAR SIR: Your letter of December 13 to Mr. W. H. Tucker, our postmaster, has been referred to me with instructions to give you as much data as we may have in our possession on the beet-sugar business. There has been some talk of locating and installing a beet-sugar plant in the vicinity, but the plans have not matured sufficiently to give you a definite idea as to what are the possibilities in that line.

It may be interesting to you to receive some information on tests that were made some three or four years ago in three of the counties adjacent to Toledo: Beets grown in Wood County averaged 14 per cent sugar, and 79.1 purity; in Lucas County, 12.7 sugar, 76.4 purity; in Henry County, 15.2 per cent sugar, 82.6 purity. At that time 44 specimens were tested and only 3 went below 10 per cent sugar, while some were above 20 per cent sugar and 2 above 90 in purity. The 3 that went below 10 per cent sugar in Lucas County reduced the average to 12.8 per cent and the purity to 76.4.

The section around Toledo is very well adapted to beet growing, owing to the great area of marsh land which can be reclaimed by dykes.

OKLAHOMA.

At various times consideration has been given to the beet-sugar industry by various commercial clubs and organizations representing different sections of Oklahoma. Most of the plans proposed have been of a tentative character, awaiting the results of experiments. During this season Shawnee had under consideration two different propositions contemplating the building of a 500-ton beet-sugar plant. Both of these received active consideration and aroused public interest. At the present time negotiations are under way with no definite conclusions in sight.

Among others interested in establishing the beet-sugar industry in this place is the Western American Colonization Company, which has given the subject considerable attention and investigation.

OREGON.

Oregon has had one factory for some time. During the past season the extension of the beet-sugar industry in the State has been under consideration at a number of points. Some of these places grow beets and other crops by rainfall, as in the La Grande district, and some have irrigation or are developing systems for the purpose of irrigation. Lack of railroads has been the great retarding factor in beet-sugar development in this State. Nearly all the projects under contemplation have in view building railroad extensions in order to accommodate the establishment of the beet-sugar industry.

BEND.—This place has been under consideration by capitalists and others interested in the beet-sugar industry through the instigation of the Dechutes Irrigation Company. About 8,000 acres of land has been secured for this purpose, and the same has been tested experimentally during the past year.

I am of the opinion that this area is particularly adapted to the growing of sugar beets and all other root crops; but at present the lands are from 70 to 100 miles from railroad and have a limited population. These drawbacks make the erection of a beet-sugar factory an impossibility at the present.

ONTARIO.—The citizens of this place had under consideration during the season a proposition for establishing at that place a 500-ton plant.

ARCADIA.—The Utah Sugar Company is investigating conditions here, and considerable interest has been developed with reference to establishing a plant at this place. The district is rather well settled and developed agriculturally, and possesses many naturally favorable conditions.

SOUTH DAKOTA.

On several occasions different communities in South Dakota have considered the establishment of beet-sugar factories. This State through its experiment station has carried on extensive well-directed experiments in growing beets. The existence of favorable conditions has been well established around such places as Watertown, Sioux Falls, Brookings, Mitchell, and Aberdeen. All of these places have at different times negotiated with capitalists for the purpose of installing beet-sugar factories. Under the conditions and environments of each beets would be grown by rainfall. During the season consideration of the beet-sugar industry became quite spirited in Belle Fourche. The agitation at this place was occasioned by the improvement of the Belle Fourche irrigation ditches, under the direction of the United States Reclamation Bureau. This irrigation system will recover and bring into use a large resourceful tract of land. It is the first irrigated section to come under consideration in South Dakota with a view to pro-

ducing sugar. Plans for this enterprise are developing with the construction of the irrigation system. Enough has been established to indicate a strong probability of a factory being built at this place in the near future.

UTAH.

The history of sugar production in Utah has shown a gradual and uniform development. It was the third State in the Union to produce sugar from beets. The first factory was established at Lehi in 1891 of 350 tons daily capacity. As the work of producing sugar beets became more familiar to the growers, and the territory producing them was extended, additional capacity was added to the plant. This was accomplished by means of slicing stations established in different valleys, in order to accommodate the growers. The capacity of this plant has been increased in this way to 1,200 tons daily, and it now has slicing stations at Springville, Spanish Fork, and Provo, each with a capacity for slicing 350 tons per day. Generally two of the stations and the plant work at the same time. The plant was not able to keep up with the progress of beet growing in this way, and it became necessary for it to install an additional factory at Garland, up in the southern end of the Bear River Valley. What has been true of this plant in developing its beet-growing area and capacity for sugar production is also true of the Amalgamated Sugar Company, which built its first plant at Ogden, Utah, and a later one at Logan. It has already largely increased the capacity of these two plants, and during the past season it built another one at Lewiston, in the northern part of the State. The factory capacity has simply expanded with the development of beet production. Each of these companies is considering the further extension of the beet-sugar industry in the State.

MORONI.—The Utah Sugar Company at Lehi has been receiving a large portion of its beets from San Pete and Sevier counties some 50 or 60 miles southwest of its location. Sugar-beet production has grown to such an extent in this district that the growers have been demanding the construction of a sugar factory to accommodate them. Negotiations have been carried on with others outside the Utah Sugar Company. Considerable rivalry has developed between the farmers in the two counties as to the location for the proposed factory. During the season the Utah Sugar Company finally adjusted the matter with a proposition to locate a factory under certain conditions in San Pete County, the Sevier County growers to deliver their beets to this factory during the campaign of 1906. The conditions were that the farmers were to bind themselves to grow a certain amount of beets for the factory and furnish a site and the usual requirements. Under the terms of this proposition a second factory is to be built in Sevier County in 1907. These plants are to have a capacity of 500 tons each.

OTHER PLACES.—Sugar beets are grown now quite generally throughout the cultivated parts of Utah. In other places the installation of factories has been under consideration. Conditions have been well demonstrated through the actual work of growing beets for considerable periods.

WASHINGTON.

Washington has had one factory manufacturing sugar from beets for eight years. For this plant beets are grown under natural moisture conditions.

Further extensions of the beet-sugar industry will probably occur in districts under irrigation. There are several places in the State that have been thoroughly investigated with the result that conditions have been found most favorable. As a rule, these depend upon irrigation. Beets grown in the State are found to be of high quality. It has already developed the largest beet-seed-producing industry. The extension of the sugar industry in the near future in the State, as shown by present indications, will probably occur at the following places:

ELLENSBURG.—At this place considerable interest has been aroused during the season. It has had under consideration the establishment of a sugar factory of 600 tons daily capacity. The Northern Pacific Railroad runs through this place and has done considerable to encourage the proposition. In the vicinity there is an excellent body of land adapted to growing sugar beets of good quality and quantity. Six thousand acres of land under contract is required. This has been secured, and $200,000 local capital subscribed. In order to encourage beet growing, business men and leading farmers organized companies of sugar-beet growers, leasing tracts of land of 150 to 1,000 acres. Ellensburg is situated in Kittitas Valley in the county of the same name.

NORTH YAKIMA.—In the vicinity of North Yakima has been developed an area of 75,000 acres of excellent land. For several years beets have been grown in this vicinity experimentally. The yield is good and the quality high. There have been several projects for establishing beet-sugar plants at this place. Through the agitation growing out of these, conditions have been pretty thoroughly investigated. During the season two of these were under consideration with indications that two plants of 1,000 tons each would be built. North Yakima is in Yakima County, in the southern central part of the State. Lands are irrigated with water from the Yakima River. In order to get definite information touching the erection of a plant, I wrote to Mr. Alex. Miller, of North Yakima, who has been active in encouraging the enterprise, and received his report as follows:

DEAR SIR: In reply to your favor will say that the parties that were going to put in a sugar factory postponed final action, owing to their being unable to secure acreage enough,

because the farmers here make much money out of their land in other crops, as they always receive large yields under irrigation, which is the principal farming method in Yakima Valley. We expect in time that beet growing will be taken up.

WISCONSIN.

For several years Wisconsin has been producing sugar from beets. Its first factory was located at Menomonee Falls. This concern has been very successful in demonstrating conditions adapted to the beet-sugar industry in the various parts of the State. The factory has always secured enough beets to insure a long campaign. Last year two factories were constructed, one at Janesville and the other at Chippewa Falls. For new plants the results of both have been satisfactory. The operation of these two plants has tended to assist the one at Menomonee Falls in the general upbuilding of the industry in the State. A factory of 600 tons capacity is now building at Madison.

In some of the districts growing beets for these factories tobacco has been one of the principal crops, especially at Madison and Janesville. The county in which Madison is located grows annually about 12,000 acres of tobacco, and that in which Janesville is located about 10,000. The beet crop is becoming popular with the tobacco growers. The best crops secured in these districts, both in quality and yield, are those grown by experienced tobacco growers on tobacco land. Both involve intensive cultivation and leave the ground in splendid shape for the crop succeeding it in the rotation.

Results in Wisconsin justify considerable extension of the beet-sugar industry in the State. Factory installation is proceeding along the right lines. As soon as a district has grown sugar beets sufficiently, and farmers are well advised regarding methods, a new factory is built to meet the demand. In this way the experience of the State is similar to that of Utah. Under such conditions there can be no mistake in the installation of factories. During this season several places received serious consideration by the factory people of the State and outside capitalists. They are as follows: Menomonie, Kaukauna, Dodgeville, Lancaster, and Sparta.

WYOMING.

The State of Wyoming has been under investigation and experimentation for some time. It has conditions very favorable to beet-sugar production. Beets grown almost anywhere in the valleys of Wyoming show unusually high quality. Where sufficient water is developed for irrigation, the soils generally return a good yield of sugar beets. The State has large deposits of coal and crude oil, both of which furnish cheap and good fuel. These conditions have attracted capitalists and investors generally. Both the large sugar concerns operating in Utah and some of those in Colorado have been

giving this State special investigation. Conditions favorable to the establishment of the sugar industry are generally conceded by all. The principal drawback is its lack of railroad and irrigation facilities. In order to carry into execution the many plans now being arranged to develop the sugar industry, transportation and irrigation must be developed. Wyoming landowners, business men, ranchmen, and others have made many excursions into the States of Colorado and Utah during the season to study the benefits of the beet-sugar industry. At the same time high officials in railroad companies, eastern capitalists, and managers of sugar concerns have jointly and separately visited the State, investigating its advantages for sugar production. Many plans are now being arranged to bring about the installation of sugar factories and the introduction of other improvements necessary to their success and the general settlement and improvement of the district. Natural conditions are somewhat similar to those in Colorado. Indications point to the opening of this State in the near future to the work of sugar production. There are several plans maturing. We are likely to see this State, like Idaho, suddenly jump into prominence in this industry.

The places having plans most nearly matured at the present time and possessing conditions adapted to the industry are as follows:

EVESTON.—Eveston is in the midst of a large stock-raising industry. The stockmen have been investigating the sugar industry and feel that such an enterprise would be materially helpful to feeders.

GRAND ENCAMPMENT AND SARATOGA VALLEYS.—These places have received considerable attention during the season from investors and those representing large railroad interests. The interest here is principally stimulated by the Union Pacific Railroad. Eastern people have invested in about 300,000 acres of land, which is to be reclaimed. The sugar industry is regarded as the principal means for accomplishing this. The scheme anticipates the building of three or four factories in these two valleys.

LOVELL.—Lovell is in a locality settled largely by Mormons from Utah. For this reason the people are especially interested in sugar production. The Utah Sugar Company has given this place considerable favorable investigation, and prospects are fair for the establishment of a factory here in the near future.

SHERIDAN.—Sheridan is in the northern part of the State in Sheridan County on the Burlington and Missouri River Railroad. The district has been thoroughly investigated by many parties interested in beet-sugar production. A factory at this place seems quite probable in the near future.

WORLAND.—This is on the Burlington Railroad and in the Big Horn Valley. Farmers here have contracted to grow 1,500 acres of beets for the factory at Billings, Mont., for the campaign of 1906. It is thought that plans already outlined for this place will mature and that

a factory will be established here for the campaign of 1907. As yet the country is quite new. Agricultural production is aided through irrigation from the Hanover Canal. The plans for establishing a factory here include the building of a new railroad, opening up a very valuable and desirable area for growing beets and other field crops.

OTHER PLACES.—Rawlins and Wheatland are two other places which have been considered to some extent. Lands have been tested, and negotiations looking to the establishment of factories have been under consideration. Enough has been established to warrant the conclusion that these places are adapted to the beet-sugar industry.

STATISTICS OF THE SUGAR INDUSTRY.

Under this heading I include (1) tabulated information relating to the beet-sugar industry in the United States; (2) statistics of the world's sugar production compiled from the reports of Willett and Gray; and (3) some interesting statistics showing improvement of sugar beets in Europe.

STATISTICS OF THE BEET-SUGAR INDUSTRY OF THE UNITED STATES FOR 1905.

This information is presented in substantially the same form as in my previous reports. In nearly all cases the figures for production have been furnished by the factory managers. As the managements of these concerns are in most cases averse to making public the facts relating to their operations, these statistics are given in such a way as to conceal the identity of the individual factories.

In the first of the two tables the data are given by States. Where there is more than one factory in a State the data have been combined, so as to show the totals and averages for all the factories in the State. In several cases, however, there is but a single factory in a State. Here, to avoid giving publicity to facts relating to individual concerns, the data for all such factories are combined (see "other States" at bottom of table).

In the second table are given the averages for tonnage of beets per acre, percentage of sugar in beets, coefficients of purity, extraction of sugar, and the length of campaigns for the individual factories. Here, again, the identity of the individual concerns is concealed by the use of numbers instead of names of factories, and the data for a number of factories have been combined (see "averages of all others" at bottom of table).

The figures for acreage may be presumed to be as reliable as such statistics usually are. Still it must be remembered that farmers seldom know the exact area of their fields, and in more than one-half the cases the factory managers have merely estimated the acreage in "round numbers."

The figures for tonnage of "beets worked" are doubtless fairly accurate, though "round numbers" were reported for about one-half the factories.

The tonnage of beets per acre was calculated from the data for acreage and tonnage of beets worked and involves no elements of doubt or error, except such as might result from inaccuracies in reporting acreage and tons of beets worked.

As the factories have exact knowledge concerning the amount of sugar produced, the figures under this head should be reliable. Still about one-half the factories reported in "round numbers." In some cases this was doubtless owing to the report being made before the manufacture of sugar for the year had entirely ceased.

The percentage of sugar in the beets, the coefficients of purity, and the length of campaigns are given as reported.

The extraction of sugar has been calculated from the figures for production of beets and sugar and involves only such errors as might result from inaccuracies in reporting tons of beets worked and tons of sugar produced. It should be noted, however, that in a number of cases the figures for extraction appear to be unreasonably high. This may in some instances have resulted from reporting as part of the year's product the sugar made from residues of brown sugar and molasses held over from the previous year.

The general averages for tons of beets per acre and extraction of sugar have not been found by taking "straight" averages of the figures for individual factories, but have been derived directly from the grand totals of acreage and production for the whole country. The general averages for percentage of sugar in the beets and coefficients of purity are merely "straight" averages derived from the figures reported for the individual factories. As a number of factories did not report on the quality of the beets worked, and these were in some instances factories whose results were presumably below the average, the general averages may be accepted as a little too high.

General factory and farm results for 1905 by States.

State.	Area harvested.	Average yield of beets per acre.	Beets worked.	Sugar manufactured.		Average sugar in beets.	Average purity coefficient of beets.	Average length of campaign.	Estimated average extraction of sugar.
				Pounds.	Tons.				
	Acres.	*Tons.*[a]	*Tons.*[a]			*Per ct.*	*Per ct.*	*Days.*	*Per ct.*
California	51,857	9.92	514,391	147,786,900	73,893.45	17.27	81.38	91.5	14.37
Colorado	85,916	10.19	875,154	183,216,900	91,608.45	14.71	81.79	101.1	10.47
Idaho	16,800	8.63	145,000	31,000,000	15,500.0	14.47	84.3	47.7	10.69
Michigan	77,823	6.83	531,475	132,917,999	66,458.99	15.65	84.67	88.9	12.32
Nebraska	16,218	7.08	114,833	22,174,400	11,087.2	12.3	77.0	99.5	9.66
Utah	27,750	8.02	222,660	48,428,000	24,214.0	14.03	80.85	66.2	10.87
Wisconsin	14,000	8.86	124,000	28,487,029	14,243.51	15.0	83.0	85.0	11.49
Other States[b]	17,000	8.14	138,400	31,830,000	15,915.0	15.78	85.2	71.0	11.5
Total and average	307,364	8.67	2,665,913	625,841,228	312,920.60	15.33	82.96	76.6	11.74

[a] Short tons of 2,000 pounds.

[b] States in each of which there is but a single factory.

General factory and farm results, by individual factories, for 1905.

Number of factory.	Average yield of beets per acre.	Average sugar in beets.	Average purity coefficient of beets.	Length of campaign.	Average extraction of sugar.
	Tons.[a]	*Per cent.*		*Days.*	*Per cent.*
1	10.83	.....	.....	45	10.0
2	7.95	17.23	82.88	50	13.65
3	5.67	.....	.....	60	10.0
4	6.60	15.2	84.0	60	13.55
5	8.0	15.35	86.5	78	12.54
6	11.54	17.9	79.4	76	[b]15.6
7	9.8	14.9	81.0	125	12.0
8	5.0	16.2	83.9	58	13.0
9	7.28	.....	.....	56	11.92
10	6.31	15.96	86.26	90	13.62
11	7.14	.....	.....	47	11.0
12	7.33	14.13	.....	63	10.61
13	7.33	15.1	.....	60	10.61
14	7.11	16.0	85.0	49	13.44
15	6.12	.....	.....	87	9.71
16	8.0	15.2	.....	58	12.5
17	3.68	15.0	85.0	25	10.71
18	12.5	.....	.....	114	11.0
19	10.66	18.0	86.0	160	13.62
20	7.88	15.3	85.51	44	13.51
21	6.67	.....	.....	67	11.0
22	3.92	16.0	85.0	37	12.5
23	7.42	12.3	77.0	112	9.64
24	7.0	.....	.....	59	11.79
25	6.2	.....	.....	70	12.1
26	10.87	14.96	79.7	73	12.52
27	8.07	15.1	81.7	90	10.56
28	7.97	15.0	.....	60	11.94
29	11.18	13.9	83.4	68	10,53
30	9.87	14.25	83.2	83	11.15
31	9.87	14.2	83.2	95	.....
32	9.0	15.0	83.0	113	11.7
33	8.57	16.0	86.0	40	[b]14.17
34	9.05	17.0	80.0	95	[b]14.62
35	5.0	.....	84.0	72	9.25
36	8.87	14.5	84.5	50	10.91
37	8.4	14.8	82.0	65	12.62
38	10.0	.....	.....	95	11.5
39	9.04	18.5	80.0	95	13.02
40	10.12	16.2	85.2	100	12.54
41	7.41	15.6	82.5	60	12.29
42	8.75	12.1	78.1	65	10.0
43	6.97	12.63	78.5	30	11.91
44	7.29	.....	.....	75	10.47
45	6.95	17.1	86.45	55	[b]15.14
Average of all others	10.79	15.23	82.95	108	10.02
Averages	8.67	15.33	82.96	76.6	11.74

[a] Short tons of 2,000 pounds.

[b] These figures are unreasonably high. It appears probable that there is some inaccuracy either in the tonnage of beets worked or in the tonnage of sugar produced as reported by these factories. In some cases the tonnage of sugar reported for the year is too high, owing to the inclusion of sugar made from residues of brown sugar and molasses held over from previous year.

SUGAR PRODUCTION OF THE WORLD.

The following table shows the production of sugar for the world for the five years beginning with 1901–2 and ending with 1905–6:

Sugar production of the world.

[Prepared in the Division of Foreign Markets, Bureau of Statistics.]

Country.	1901–2.	1902–3.	1903–4.	1904–5.	1905–6.
CANE SUGAR.					
United States:	*Tons.*[a]	*Tons.*[a]	*Tons.*[a]	*Tons.*[a]	*Tons.*[a]
Louisiana and Texas	321,676	329,226	234,800	350,000	342,000
Hawaii	317,509	391,062	328,103	380,576	370,000
Porto Rico	85,000	85,000	130,000	145,000	210,000
Total United States [b]	724,185	805,288	692,903	875,576	922,000
Cuba	850,181	998,878	1,040,228	1,163,258	1,300,000
Other West Indies	282,410	260,163	268,306	241,586	249,000
Mexico	103,110	112,679	107,547	107,038	105,000
Central America	20,500	21,500	21,450	19,768	22,000
South America	761,805	579,022	601,134	590,382	693,308
Total America	2,742,191	2,777,530	2,731,568	2,997,608	3,291,308
Asia	2,868,243	2,839,596	2,841,547	3,281,931	2,854,825
Africa	278,926	277,473	321,706	232,101	295,000
Oceania	169,858	133,126	163,328	214,688	223,000
Europe	28,000	28,000	28,000	28,000	28,000
Total cane-sugar production	6,087,218	6,055,725	6,086,149	6,754,328	6,692,133
BEET SUGAR.					
United States	163,126	195,463	208,135	209,722	283,717
Canada	.....	6,696	6,710	8,034	11,419
Total America	163,126	202,159	214,845	217,756	295,136
Europe:					
Germany	2,305,013	1,762,461	1,927,681	1,598,164	2,425,000
Austria-Hungary	1,301,548	1,057,692	1,167,959	889,373	1,510,000
France	1,123,545	833,210	804,308	622,422	1,085,000
Russia	1,098,983	1,256,311	1,206,907	953,626	1,000,000
Belgium	324,960	224,090	209,811	176,466	330,000
Netherlands	203,193	102,411	123,551	136,551	210,000
Other countries	393,236	325,082	441,116	332,098	410,000
Total Europe	6,750,478	5,561,257	5,881,333	4,708,700	6,970,000
Total beet-sugar production	6,913,604	5,763,416	6,096,178	4,926,456	7,265,136
Total cane and beet sugar production.	13,000,822	11,819,141	12,182,327	11,680,784	13,957,269

[a] In long tons of 2,240 pounds, except in the case of European beet-sugar production, which has been retained in metric tons of 2,204.622 pounds, as originally estimated by Licht. Other data are mainly from Willett & Gray, but in the case of India official estimates of production have been substituted.
[b] Not including the Philippine Islands, which are included under Asia.

IMPROVEMENT OF BEETS IN EUROPE.

Below I offer some statistics taken from a report[a] prepared by F. R. Rutter, assistant chief of the Division of Foreign Markets, United States Department of Agriculture.

These tables will show the gradual improvement of quality of beets in Germany, Austria-Hungary, France, Russia, and Sweden, and the consequent gradual increase in the amount of sugar produced per acre in these foreign countries.

[a] Bul. 30. Bureau of Statistics: International Sugar Situation.

This is highly illustrative of the claims I have made in my reports that it takes years of experience in any locality or country to place the sugar industry at its highest efficiency.

AVERAGE YIELD OF BEETS.

During the last twenty years there has been a striking improvement in the methods of beet culture in the leading countries of Europe. The improvement has resulted not so much in the increased yield of beets per acre as in the larger sugar content of the beets.

In Germany, for instance, the average yield per acre in 1902 was less than 12 short tons per acre. This yield, however, was much below the average. For the last five years the average yield per acre was about 13 short tons, while the average yield for the five years 1882–86 was about 14 tons per acre. By care in the selection of mother beets and in the methods of fertilization and culture, the quality of the beet has been greatly improved, partly at the expense of tonnage. The factories require beets light in weight and rich in sugar.

AVERAGE SUGAR EXTRACTION.

The increase in the average amount of sugar obtained from a given quantity of beets is shown in the following table:

Average extraction of sugar from beets (in percentages of weight of beets) in European countries, 1882–1904.

Sugar year.	Average extraction of sugar in—				
	Germany.	Austria-Hungary.	France.	Russia.	Sweden.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
1882–83	9.51	10.06	5.05	8.51	.....
1883–84	10.54	11.23	5.65	9.41	7.81
1884–85	10.80	11.66	6.00	9.45	9.11
1885–86	11.43	11.75	8.20	9.58	9.06
1886–87	12.26	11.83	9.55	10.03	10.30
1887–88	13.77	12.31	9.92	10.12	10.98
1888–89	12.55	10.73	10.25	11.25	10.31
1889–90	12.84	11.69	11.08	10.65	10.69
1890–91	12.58	11.39	9.87	10.48	9.45
1891–92	12.63	11.51	10.83	12.55	10.32
1892–93	12.54	11.10	10.04	12.16	10.78
1893–94	12.83	12.48	10.28	11.38	11.54
1894–95	12.59	11.80	10.43	10.98	11.60
1895–96	14.02	13.36	11.54	12.89	10.75
1896–97	13.27	11.79	10.38	12.16	11.86
1897–98	13.46	11.91	12.07	11.98	12.42
1898–99	14.18	13.27	12.81	12.38	12.33
1899–1900	14.43	12.85	12.42	12.02	12.99
1900–1901	14.93	14.26	12.62	13.66	13.10
1901–2	14.38	14.40	11.87	12.98	13.87
1902–3	15.87	14.71	13.14	13.07	14.34
1903–4	15.18	14.85	12.33	15.42	.....

PRODUCTION OF SUGAR PER ACRE.

The average yield of beets per acre and the average sugar extraction shown in the above table bring out different aspects of the progress in the beet-sugar industry. A more accurate measure of improvement, both on the farm and in the factory, is the average sugar production per acre, as shown in the following table:

Average production of sugar per acre in European countries, 1882–1904.

Sugar year.	Average production of sugar per acre in—				
	Germany.	Austria-Hungary.	France.	Russia.	Belgium
	Pounds.	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*
1882–83	2,917	1,873	1,588	1,110	.....
1883–84	2,811	.....	1,750	1,008	.....
1884–85	3,169	2,015	1,621	1,008	.....
1885–86	3,089	1,814	2,071	1,444	.....
1886–87	3,281	1,894	2,752	1,427	.....
1887–88	4,890	1,722	2,328	1,525	.....
1888–89	3,155	1,954	2,478	1,717	.....
1889–90	3,768	2,282	3,126	1,536	.....
1890–91	3,619	2,127	2,382	1,518	.....
1891–92	3,180	2,146	2,433	1,566	.....
1892–93	3,120	2,062	2,165	1,371	.....
1893–94	3,159	2,050	2,144	1,719	3,766
1894–95	3,697	2,277	2,656	1,591	3,177
1895–96	3,870	2,320	2,767	1,806	3,225
1896–97	3,819	2,426	2,916	1,754	3,475
1897–98	3,761	2,380	3,094	1,589	3,351
1898–99	3,610	2,584	2,872	1,518	3,468
1899–1900	3,757	2,940	2,862	1,615	4,068
1900–1901	3,950	2,767	2,926	1,493	3,981
1901–2	4,297	3,165	2,813	1,789	4,071
1902–3	3,728	3,028	2,919	1,704	3,553
1903–4	4,144	3,352	3,031	1,922	3,008

REPORTS FROM AGRICULTURISTS OF SUGAR FACTORIES.

ON THE PRACTICE OF IRRIGATION.

In order to get an idea of the practical methods in vogue in various beet-growing districts under irrigation, I wrote a letter to the agricultural superintendents connected with western factories, soliciting replies to eight questions. These were arranged to bring out the information usually sought by those investigating this subject.

Below will be found my communication, followed by the replies of the superintendents:

I am preparing for my next annual report a chapter on irrigation. As you are doubtless deeply interested in the upbuilding of the beet-sugar industry and are familiar with the practical work of growing beets under irrigation, I wish you would prepare for me a statement of facts, based on your experience, in answer to the following questions:

1. What about "irrigating up" the beets?
2. At what stages is irrigation most beneficial?
3. What do you estimate the rainfall to be in your district during the growing season?
4. With the usual rainfall, how many times do you irrigate?
5. How much water do you put on the land in one irrigation—how much altogether?
6. What does each irrigation cost per acre, how much of this cost is due to cost of water, how much is due to cost of labor, etc.?
7. Is the general tendency among farmers to overirrigation or underirrigation?
8. What is the general price of water in your district?

REPLIES TO QUESTION NO. 1.

Grand Junction, Colo.—"We irrigate up practically all our beets."

Lehi, Utah—Springville Station.—"Very few irrigated up."

Rocky Ford, Colo.—"Last season the largest portion of the beets came up without irrigation on account of frequent showers. A portion was irrigated up successfully by running the water in every other row, the furrows being made with shovels attached to the seeder."

Grand Island, Nebr.—"We had plenty of rain; had no occasion to irrigate before beets came through ground."

Holly, Colo.—"We have had a great deal of experience in irrigating up beets, and when the water can be secured at the proper time have found this method very successful."

Lehi and Garland, Utah.—"As a rule it is very unsatisfactory to irrigate beets up. It usually leaves the land in a very bad condition for thinning and cultivating."

REPLIES TO QUESTION NO. 2.

Grand Junction, Colo.—"After irrigating up our next irrigation is right after the thinning, and from that time on we irrigate whenever the beets seem to need water."

Lehi, Utah—Springville Station.—"July and August when beets cover ground."

Rocky Ford, Colo.—"Time of irrigation depends upon condition of soil and rainfall during spring; it is usually advisable to delay irrigation until the beets have been thinned and then apply about two irrigations."

Grand Island, Nebr.—"After first hoeing is completed."

Holly, Colo.—"Irrigation is most beneficial during the hot dry summer season and during the time the plant is growing, before it has gotten very large."

Lehi, Utah—Springville Station.—"In May, generally enough for one watering."

REPLIES TO QUESTION NO. 3.

Grand Junction, Colo.—"Our rainfall here is very irregular and we can not figure on it at all as far as beet raising is concerned."

Lehi and Garland, Utah.—"Rainfall is very uncertain in this State; some seasons not more than 2 inches from May 1 to October 1; some seasons we have 6 inches.

Rocky Ford, Colo.—"Average annual rainfall amounts to 12 inches."

Grand Island, Nebr.—"From 18 to 20 inches in this locality."

REPLIES TO QUESTION NO. 4.

Grand Junction, Colo.—"Not having any rainfall, we irrigate four or five times in a season."

Lehi, Utah—Springville Station.—"From two to five times, owing to quality of land."

Rocky Ford, Colo.—"With the usual rainfall two or three irrigations are applied."

Grand Island, Nebr.—"The usual rainfall in irrigated districts in western Nebraska is not over 12 to 14 inches during the growing period. In addition to this we irrigate two or three times."

Holly, Colo.—"With our usual rainfall we irrigate from three to four times during the growing season."

Lehi and Garland, Utah.—"Usually we irrigate three to four times, applying about 3 inches of water each time."

REPLIES TO QUESTION NO. 5.

Grand Junction, Colo.—"Will say that we figure from one-half to 1 inch in depth of water per acre for one irrigation."

Lehi, Utah—Springville Station.—"One second-foot two hours per acre."

Rocky Ford, Colo.—"No measurements have been taken regarding amount of water applied in one irrigation, but probably not less than three-fourths acre-foot in each irrigation."

Grand Island, Nebr.—"No measurements kept as to amount of water used."

Holly, Colo.—"We put on sufficient water to leave the soil in good moist condition, and it is difficult to measure this as it varies according to the soil.

REPLIES TO QUESTION No. 6.

Grand Junction, Colo.—"In regard to irrigation, will say that I can not tell how much it costs. Water rental here is $3 an inch per year. They pay for labor here from $1.50 to $2.50 per day."

Lehi, Utah—Springville Station.—"Fifty-five cents per acre in all. Twenty cents per hour for labor, 5 cents for water—that is, where water is brought to land. Cost for bringing water to land is 50 cents per acre."

Rocky Ford, Colo.—"The cost of irrigation depends very much upon the lay of the land. If very uneven, very level, or very much grade the work is more difficult. Under average conditions each irrigation will cost about 50 to 75 cents per acre on account of labor. There is no charge for water, as the landowners own their stock in the ditches, the maintenance and repair of which usually costs from 50 cents to $1 per acre of land watered."

Grand Island, Nebr.—"Twenty-five cents."

Holly, Colo.—"Irrigation costs about 50 cents per acre each time—25 cents for the water and 25 cents for the labor."

Lehi and Garland, Utah.—"Cost, about 50 cents per acre for labor for each irrigation; an additional charge of about $1 per acre for the maintenance of permanent canals for the season; and I would say about $1 per acre per annum for preparation for irrigation of beets."

REPLIES TO QUESTION No. 7.

Lehi, Utah—Springville Station.—"Farmers have learned that too much irrigation is as detrimental as not enough."

Rocky Ford, Colo. "If the farmers have a fair water supply there is a general tendency to overirrigate.

Grand Island, Nebr.—"Majority of growers are inclined to overirrigate the first few years."

Holly, Colo.—"The general tendency among farmers is toward overirrigation."

Lehi and Garland, Utah.—"As a rule the farmers are inclined to overirrigate until experience has taught them that too much water does not increase tonnage."

REPLIES TO QUESTION No. 8.

Lehi, Utah—Springville Station.—"About 75 cents per acre. By prior right that water belongs to the farmers. By usage we only pay for the regulating of it; that means cleaning ditches and a man to time each farmer."

Rocky Ford, Colo.—"Water rights to irrigate 80 acres are sold in this district at from $2,400 to $3,000, but the price is steadily increasing."

Grand Island, Nebr.—"Water can only be secured by parties owning water rights. Maintenance costs about 39 cents per acre."

Holly, Colo.—"Water in this district is not sold. Land is sold at various prices and the water is included with the price of the land."

ON OPERATIONS IN BEET-GROWING DISTRICTS IN 1905.

Below will be found reports from various agricultural superintendents in response to the following letter of inquiry:

DEAR SIR: The Secretary of Agriculture is very anxious in the annual report on "The Progress of Beet Sugar Industry" to cover the field with as reliable, comprehensive, and complete information as possible. For the purpose of checking up my own observations and information on the subject I would be under many obligations if you would give a brief résumé of the conditions affecting the beet-sugar industry in your locality during the past season. The character of the information desired is indicated by the questions below. You can write as fully or as briefly as is consistent with your time and inclination.

All of us who participate in this work have some ideas worthy of publication, and I am especially desirous of including in this report the practical information and experience of the agriculturists of our sugar factories.

1. Describe the past season as affecting sugar-beet growing.
2. Is the beet crop growing in favor with farmers, and what are the causes affecting their attitude?
3. What new features have you developed that are favorable to the beet growing under your conditions?
4. What experiments have you conducted with fertilizers, beet seed, etc., and with what results?
5. Have any new labor-saving implements been brought out in your district?
6. Have any new labor-saving implements, local or otherwise, been tried in your district, and with what results?
7. How many contracting farmers has your company?
8. How many acres of beets were harvested?
9. What price do you pay for beets?
10. What are the prospects for 1906?
11. What seed do you usually plant, with proportion of different kinds?
12. Describe the kind of land, under your conditions, that gives the best results.
13. Under general remarks give anything you care to mention that will be of interest.

REPLIES TO QUESTION NO. 1.

Alma, Mich.—"The season with us has been very discouraging, especially the forepart, which was very wet and quite warm. The ground seemed to sour worse than in a wet, cold season. Nothing grew the forepart of the season. The latter part was much more favorable; but we had some quite dry weather, which dried the ground that had been worked and puddled while too wet, and made it so hard that when harvesting began October 1 it was necessary in many instances to use two teams or three horses on one lifter to loosen the beets."

Alvarado, Cal.—"All crops were poor last season."

Janesville, Wis.—"We had a fairly good season here during 1905. The only drawback we had in the way of weather was some heavy rains about the time beets were planted which washed out a good many of the young plants, necessitating considerable replanting. Later in the season we had a period of dry weather that affected them slightly. To put it in common phrase, 'when it was wet it was too wet, and when it was dry it was too dry.'"

Lansing, Mich.—"The past season has been particularly trying in general. About 25 per cent of the acreage was destroyed by the excessive rains of the latter part of May and the first of June, our heaviest rainfall occuring on June 3, at which time there was a total fall of about 7.2 inches in twenty-four hours. Aside from this the season was fair in general."

Lehi, Utah—Springville Station.—"Had blight. Raised about 50 per cent of what we generally raise, or about 8 tons per acre. All those who have contracted took their full acreage. I think we will have as many acres planted for season of 1906 as formerly."

Lyons, N. Y.—"Conditions on the whole have been fair, but the crop was damaged in some sections of the State by wet weather."

Owosso, Mich.—"The early part of last season was extremely wet and in ten days' time we lost about 3,000 acres. When the extreme wet weather did let up the planting of the beet seed was late, and on account of the lateness in planting the beets did not mature; consequently the tonnage was light and the sugar per cent low. This was the condition in some of our best districts."

Rocky Ford, Colo.—"The season was not favorable for the growth of the crop. The spring was cold. Hailstorms damaged the crop quite frequently during the summer, also insects."

Saginaw, Mich.—"The season was wet and very unsatisfactory."

Grand Junction, Colo.—"The past season we had a regular beet blight, which they had all over the country, and this affected us considerably in beet tonnage."

Grand Island, Nebr.—"Had entirely too much rain and cold weather during the growing season of the crop, which damaged it considerably."

Holly, Colo.—"The past season was not very good for beet raising, owing to the fact that the spring was late, and while the crop started out well it was damaged by all kinds of insects and pests."

Lehi and Garland, Utah.—"The past season the beet crop has been very light in this State on account of the leaf hopper, or what is here known as the 'white fly.' This insect attacked the beet crop about the middle of June and in many cases almost destroyed the crop, and particularly did this occur in the late planting."

Croswell, Mich.—"The past season and its effect upon sugar-beet growing was as follows: The latter half of April and a few days in May were extremely fine for seeding; the weather was mild and conditions were favorable in every way, but from the middle of May until about June 20 we were visited every week with extremely heavy rains, which not only ruined parts of many beet fields, but also made it impossible for many to finish seeding. From June 20 until the crop was harvested the weather was ideal, the beets grew rapidly, and our sugar percentages were higher than ever before."

REPLIES TO QUESTION NO. 2.

Alma, Mich.—"The crop seems to be growing in favor with the farmers. The worst drawback with us is the labor question."

Alvarado, Cal.—"Beet crops are growing in favor with farmers."

Janesville, Wis.—"Think the beet crop is growing in favor with the farmers because they find it a safe and sure crop, and one that they have a regular market for, and know when they are going to deliver, and when they get their pay. This season we are paying 50 cents per ton more for beets than last year, and I think we will have no trouble in getting a good acreage."

Lansing, Mich.—"The beet crop in this section is growing steadily in favor with the farmers, the cause of this growth being our endeavor to fit the crop into the farmer's general routine, (1) by confining the acreage to the amount which he can take care of properly; (2) by advocating the planting of beets 28 inches apart instead of 20 inches, thus placing the crop on a par with the other successful crops on the farm, with the exception of the thinning and topping; (3) by supplying hand labor in districts where the same is lacking under general conditions."

Lehi, Utah—Springville Station.—"Yes; because there is more clear profit from beets than from any other crop."

Lyons, N. Y.—"The crop is growing in favor among farmers who have had experience on account of the uniform price of the crop."

Owosso, Mich.—"The beet crop is growing greatly in favor with the farmers. This has resulted to some extent from observations of the crop during the extreme wet weather last year and the way in which the beets stood the water. Many fields were flooded for two or three days, but many of our good growers, even with this condition, were successful in raising very fair crops, which led them to believe that in ordinary seasons beets would be the farmers' money crop."

Rocky Ford, Colo.—"Beet acreage has increased from year to year, as it proves to be the most profitable crop in this section."

Grand Junction, Colo.—"The beet crop seems to be growing more generally into favor with the farmers."

Saginaw, Mich.—"We think the beet crop is coming into favor more and more with the farmers each year."

Grand Island, Nebr.—"Yes; because they realize more per acre than from any other crop."

Holly, Colo.—"The beet crop is growing very much in favor with the farmers, owing to its money-making properties."

Lehi and Garland, Utah.—"The beet crop is certainly growing in favor with the farmers in favorable locations where soil is adapted to beet culture, water plentiful, climatic conditions favorable, and land owned in small tracts."

Croswell, Mich.—"Our farmers are beginning to consider the beet crop one of their regular crops. The reason is they are becoming better acquainted with the methods of culture and with the factory processes and find it to be a paying crop."

REPLIES TO QUESTION NO. 3.

Alma, Mich.—"Nothing new has been developed, unless we should say that the land must be extra good and the crop have care at the proper time, if we expect very profitable returns."

Lehi, Utah—Springville Station.—"Only keeping ground well fertilized."

Owosso, Mich.—"In regard to new conditions developed, we have experimented very carefully on 28-inch rows and find that on an equal number of acres of 20-inch and 28-inch rows the average tonnage on the 20-inch rows was 12.38 tons, and the average per cent of sugar was 16, while on the 28-inch rows the average sugar was 16.2 per cent, and the average tonnage 12.4 tons. Certainly the crop can be handled $5 or $6 per acre cheaper with the 28-inch rows than with the 20-inch rows, as the farmer has all his tools to work the crop. We certainly expect to make a very large experiment along the same line another year. However, the above report covers a good many acres."

Saginaw, Mich.—"New features of development are drainage and roads."

Grand Island, Nebr.—"We have secured more and better hand labor."

Holly, Colo.—"We have found that fall plowing is very good for beet land."

Lehi and Garland, Utah.—"The beet crop, unlike any other crop the farmer raises, is sold before the seed is planted. Intensive farming from commencement to finish is very necessary. The more cultivation and hoeing the better will be the returns to the farmer. We have proven that plowing under the second crop of alfalfa in the latter part of July usually gives us excellent crops of beets for the next two or three seasons. Hence this has proven to be the cheapest fertilizer for this locality."

REPLIES TO QUESTION NO. 4.

Grand Junction, Colo.—"Will say that we fertilize here as much as we can with manure and try to get all of our growers to do this. We also try to get them to fall plow."

Lansing, Mich.—"In the past season we furnished our growers with fertilizer for use on the beet fields from one of the fertilizer companies. We find that in general this has been successful, inasmuch as it has given the crop a start in the spring, which is necessary to carry it through the usually damp and cold weather and puts the crop ahead as a consequence. If no other benefit was derived from fertilizer, this alone would compensate the farmer for using it."

Lehi, Utah—Springville Station.—"When barnyard manure can not be obtained the next best thing is alfalfa plowed under in April."

Lyons, N. Y.—"Experiments have been conducted with different kinds of fertilizers and seeds, but the results not fully digested."

Owosso, Mich.—"You will find inclosed copy of report on fertilizer experiments; also one on an experiment with beet seed in regard to small and large seeds.

Results of test of beets grown from Jaensch seed screened in three sizes, large, medium, and small, 1905.

Plat No.	Size of seed.	Weight of beets.		Sugar in beets.
		Lbs.	*Oz.*	*Per ct.*
1	Large	1	1	15.9
2	Large	.....	14	15.8
3	Large	1	8½	14.8
4	Large	1	6	14.9
5	Small	1	.....	14.2
6	Small	.....	14	16.2
7	Small	.....	15	15.2
8	Small	1	.....	16.2
9	Medium	.....	8½	15.3
10	Medium	1	.....	15.9
11	Medium	2	.....	14.8
12	Medium	1	4½	15.7

This shows that we had the highest per cent of sugar from the beets grown from small seeds and also smaller beets, while the large seeds show a little larger tonnage. A great many of our experiments were unsatisfactory this year on account of weather.

The following is a summary of the experiments conducted in 1905 with a commercial brand of tobacco and potato fertilizer:

EXPERIMENT NO. 1.

Fertilization.—Plat of 0.23 acre. May 24, 200 pounds of nitrate of soda per acre sown broadcast and harrowed in before seeding; 80 pounds per acre of the commercial fertilizer sown in rows.

Result.—Gross yield, 35,217 pounds per acre; tare, 10½ per cent; net yield, 31,608 pounds, or 15.8 tons per acre; sugar, per cent, 13.4; value of crop, $79.48 per acre.

EXPERIMENT NO. 2.

Fertilization.—Plat of 0.23 acre. May 24, 100 pounds of nitrate of soda per acre sown broadcast and harrowed in before seeding; 80 pounds per acre of the commercial fertilizer sown in rows.

Result.—Gross yield, 29,587 pounds per acre; tare, 8½ per cent; net yield, 27,072 pounds, or 13.5 tons per acre; sugar, per cent, 14.7; value, $73 per acre.

EXPERIMENT NO. 3.

Fertilization.—Plat of 0.23 acre. No fertilizer of any kind.

Result.—Gross yield, 22,729 pounds per acre; tare, 15 per cent; net yield, 19,227 pounds, or 9.6 tons per acre; sugar, per cent, 13.3; value, $47.43 per acre.

EXPERIMENT NO. 4.

Fertilization.—Plat of 0.23 acre. May 24, 100 pounds of nitrate of soda per acre sown broadcast and harrowed in before seeding; 80 pounds of the commercial fertilizer per acre sown in rows.

Result.—Gross yield, 25,504 pounds per acre; tare, 9 per cent; net yield, 23,094 pounds, or 11.5 tons per acre; sugar, per cent, 14.4; value, $60.81 per acre.

EXPERIMENT NO. 5.

Fertilization.—Plat of 0.23 acre. May 24, 200 pounds of the commercial fertilizer per acre sown broadcast and harrowed in; 80 pounds of the same fertilizer per acre sown in rows.

Result.—Gross yield, 23,027 pounds per acre; tare, 6¾ per cent; net yield, 21,370 pounds or 10.68 tons per acre; sugar, per cent, 15.3; value, $59.83 per acre.

EXPERIMENT NO. 6.

Fertilization.—Plat of 0.23 acre. May 24, 600 pounds of the commercial fertilizer per acre sown broadcast and harrowed in; 80 pounds of the same fertilizer per acre sown in rows.

Result.—Gross yield, 25,504 pounds per acre; tare, 10½ per cent; net yield, 22,431 pounds or 11.2 tons per acre; sugar, per cent, 15.7; value, $64.30 per acre.

EXPERIMENT NO. 7.

Fertilization.—Plat of 0.23 acre. May 24, 80 pounds of the fertilizer per acre sown in the row.

Result.—Gross yield, 27,064 pounds per acre; tare, 7¾ per cent; net, 24,839 pounds or 12.4 tons per acre; sugar, per cent, 15.3; value, $69.55 per acre.

EXPERIMENT NO. 8.

Fertilization.—Plat of 0.23 acre. May 24, 100 pounds of nitrate of soda per acre sown broadcast and harrowed in; 100 pounds of nitrate of soda sown broadcast July 17; 80 pounds of the commercial fertilizer sown in the rows.

Result.—Gross yield, 32,110 pounds per acre; tare, 11¾ per cent; net yield, 28,158 pounds or 14 tons per acre; sugar, per cent, 14.6; value, $76.38 per acre.

EXPERIMENT NO. 9.

Fertilization.—Plat of 0.23 acre. May 24, 100 pounds of nitrate of soda per acre sown broadcast and harrowed in; 80 pounds of the commercial fertilizer per acre sown in the row.

Result.—Gross yield, 27,133 pounds per acre; tare, 13¾ per cent; net yield, 23,287 pounds or 11.6 tons per acre; sugar, per cent, 14.1; value, $60.54 per acre.

Rocky Ford, Colo.—"None."

Saginaw, Mich.—"We are introducing fertilizer more and more each year and the results have been good."

Grand Island, Nebr.—"None."

Holly, Colo.—"The only fertilizers used are barnyard manure and alfalfa plowed under, both being very successfully used."

Croswell, Mich.—"We have conducted many experiments with fertilizers and beet seed. We find that it is very profitable to use fertilizer with the beet crop; it improves the stand, increases the yield, and generally gives a better sugar content. Beet seed is also a valuable consideration; there is much difference in results obtained from different seeds, especially in sugar percentage and tonnage."

REPLIES TO QUESTIONS NOS. 5 AND 6.

Alma, Mich.—"Have tried a beet harvester with pretty fair results. The machine should bunch the tops and leave the beets in small piles, and if it did would be a success, I think."

Grand Junction, Colo.—"The only new labor-saving implement which we have here is a beet puller and topper combined, but it was sent here as a sample and we did not receive it in time to do much with it this past season and so can not tell you much about it."

Janesville, Wis.—"No new labor-saving implements have been originated in this district that we know of. There were tried in this territory two machines for topping and lifting, but they were both in rather a crude state and I do not think that they were entirely successful, although we think there is no doubt that they soon will be."

Lansing, Mich.—"No new labor-saving implements have been brought out which we consider worthy of notice. The placing upon the market of so many different tools along this line which are without merit has to a certain extent caused the farmer to dislike the beet crop, as it appears to him as a crop demanding an expenditure of a large amount of money for implements which can be practically of no other use on the farm. We submit that tools for the working of the beet crop should be built along the line of general farm implements

which can be used on other crops as well, and we advocate the planting of beets 28 inches apart in order to render this possible."

Lehi, Utah—Springville Station.—"No, not for several years."

Owosso, Mich.—"A new blocker came on the market, but for reasons already given was not a success. We also used a topper and lifter, but it was not a success."

Saginaw, Mich.—"None have been introduced with any success."

Grand Island, Nebr.—"No."

Holly, Colo.—"No new labor-saving implements have been brought out. A few small experiments have been made with labor-saving implements in this district with no results."

Lehi and Garland, Utah.—"In many cases the implements used to-day result in a great saving of labor; the horse cultivator and the beet puller, for instance, save a great deal of hoeing in the first place and make the harvesting easier and cheaper. Many suggestions have been made by us to manufacturers of the East, and as a rule have been adopted with very satisfactory results."

Croswell, Mich.—"We have tried many implements supposed to be labor saving, but none have proven to be valuable. Blocking machines and harvesters have been tried, but haven't proven satisfactory."

Lyons, N. Y.—"Some new implements have been given short trials, but not enough to determine their usefulness."

Rocky Ford, Colo.—"A beet harvester was tried in this section, but without success."

Saginaw, Mich.—"There have been some attempts, but no results."

Replies to Questions Nos. 7 and 8.

Alma, Mich.—"We had 1,185 contractors; harvested 5,471 acres of beets."

Alvarado, Cal.—"There are 300 contracting farmers here; number of acres of beets harvested, 4,511."

Grand Junction, Colo.—"We have about 800 contracting farmers; harvested last season 4,800 acres."

Janesville, Wis.—"The number of contracting farmers was about 2,200; harvested approximately 6,000 acres."

Lansing, Mich.—"We had during the past season about 1,500 contracting farmers, and we harvested 4,074 acres of beets."

Lehi, Utah—Springville Station.—"Number of contracting farmers, 300; number of acres harvested, 2,000."

Lyons, N. Y.—"About 1,500 contracting farmers; acres harvested, 4,900."

Owosso, Mich.—"The number of farmers we had contracted with last year was 2,318, and the number of acres harvested was 7,520."

Rocky Ford, Colo.—"Contracting farmers, 1,165; acres harvested, 12,761."

Saginaw, Mich.—"Farmers growing beets under contract, 1,500; acres harvested, 4,500."

Grand Island, Nebr.—"The contracting farmers numbered 468; acres harvested, 4,218."

Holly, Colo.—"We had over 500 contracting farmers for 1905 and harvested about 5,000 acres."

Lehi and Garland, Utah.—"For Lehi and Garland about 3,000 farmers, averaging about 6 acres each. Our acreage has grown from 2,000 in 1891 to 18,000 in 1905. As a rule, 95 per cent of beets are harvested. The past season, however, only about 75 per cent of the area planted was harvested on account of the white fly."

Croswell, Mich.—"We had about 1,000 contracting farmers last season and harvested 2,600 acres."

Lewiston, Utah.—"About 800 contracting farmers and 1,910 acres."

REPLIES TO QUESTION No. 9.

Alma, Mich.—"The price for beets is $4.50 for a 12 per cent sugar content, with 33⅓ cents additional for each 1 per cent rise in test. We also had a $4.75 per ton flat-rate contract for tared beets delivered at any one of our 11 weigh and tare stations, and we pay the freight."

Alvarado, Cal.—"Price of beets, $5 per ton."

Grand Junction, Colo.—"We pay $5 per ton for beets."

Janesville, Wis.—"The 1906 price for beets is $4.50 per ton for beets testing 12 per cent or less, with an additional 25 cents per ton for each percentage above 12. That is our 'contract form No. 3.' Then we have a 'contract form No. 4,' under which we pay a flat rate of $5 per ton."

Lansing, Mich.—"The price paid for beets averaged a trifle better than $5.50 per ton."

Lehi, Utah—Springville Station.—"Price for beets, $4.75 per ton."

Lyons, N. Y.—"Price of beets, $5."

Owosso, Mich.—"We pay $4.50 for 12 per cent beets and 33⅓ cents for each 1 per cent above."

Rocky Ford, Colo.—"Price of beets, $5 per ton."

Saginaw, Mich.—"Our price is $4.50 on a 12 per cent basis with 33⅓ cents per ton for each additional per cent of sugar, or a $5 flat rate."

Grand Island, Nebr.—"Price of beets, $5 per ton."

Holly, Colo.—"We pay $5 per ton for beets and 50 cents more per ton for siloed beets."

Lehi and Garland, Utah.—"The prices paid for beets in Utah delivered at factory, containing 14 per cent sugar or over and with purity coefficient of 80, is $4.75 per ton."

Croswell, Mich.—"Price per ton averaged $5.50."

Leviston, Utah.—"We pay $4.50 per ton delivered at the factory for all beets having not less than a purity of 80."

REPLIES TO QUESTION No. 10.

Alma, Mich.—"Prospects for 1906 are about fair. The scarcity of competent labor at reasonable prices keeps many from contracting, and the high prices of beans with the success of the crop last year, is turning some toward bean raising who otherwise would raise beets, if the beans had not done so very well last season."

Alvarado, Cal.—"Prospects for 1906 are better."

Grand Junction, Colo.—"Prospects for 1906 are fair, and we think that by 'rustling' we can get the required acreage. The season so far has been the finest kind of beet weather."

Janesville, Wis.—"The prospects for 1906 are very good."

Lansing, Mich.—"The prospects for the season of 1906 are of the best. We feel sure at the present time that we shall have all the acreage which our plant can handle."

Lehi, Utah—Springville Station.—"Prospects are good for 1906."

Lyons, N. Y.—"Prospects are good."

Owosso, Mich.—"Prospects were never better so far as contracts are concerned than they are for 1906. At this writing we have already contracts for 6,000 acres, and from present indications will reach 10,000 acres, our required amount."

Rocky Ford, Colo.—"Fair average will be grown for 1906."

Grand Island, Nebr.—"Prospects are pretty good."

Holly, Colo.—"The prospects for 1906 could not be brighter."

Lehi and Garland, Utah.—"The prospects for acreage the coming season are excellent. We have an abundance of snow in the mountains, which will insure a bounteous crop."

Croswell, Mich.—"Prospects for 1906 are exceedingly good, better than ever before."

REPLIES TO QUESTION No. 11.

Alma, Mich.—"Last season we planted eight different kinds of seed, viz, Braune, Dippe, Schreiber Elite, Schreiber Kleinwanzlebener, Original Kleinwanzlebener, Licht, Vorstadt, and American. The bulk of our seed was Braune, Dippe, Schreiber Elite, Original Kleinwanzlebener, and Licht.

The last-named seeds showed the following results:

Seed.	Average yield per acre.	Average sugar content.	Crop value per acre.
	Tons.	*Per cent.*	
Braune	7.91	15.9	$45.94
Dippe	8.88	16.0	52.07
Schreiber Elite	7.29	18.0	47.39
Original Kleinwanzlebener	7.54	16.2	44.62
Licht	7.34	16.5	43.88

Alvarado, Cal.—"Kleinwanzlebener seed used."

Grand Junction, Colo.—"In regard to seed will say that we plant several different kinds, but the principal one is the Kleinwanzlebener."

Janesville, Wis.—"We use Kleinwanzlebener seed."

Lehi, Utah—Springville Station.—"We use a German seed—I do not know the name."

Lyons, N. Y.—"The seeds we use are Elite Kleinwanzlebener, Heine Kleinwanzlebener, Dippe, Schreiber Special, and Original Kleinwanzlebener."

Owosso, Mich.—"Find inclosed report as to condition of seed and kinds used. Our present statistics in regard to this year's seed are not completed and we give you the last year's report."

Seed results at Owosso, Mich., campaign of 1904.

Seed.	Number of contracts.	Average size of contract.	Total area.	Tonnage of beets.	Value of beets.	Yield per acre.	Sugar content.	Crop value per acre.	Sugar per acre.	Value per ton.
Breustedt:		*Acres.*	*Acres.*	*Tons.*		*Tons.*	*Per ct.*		*Lbs.*	
Postcontract.	189	4.4	824.9	8,349.6	$47,950.70	10.10	15.72	$57.97	3,175	$5.74
Others	39	6.3	246.9	2,023.6	11,766.97	8.19	15.93	47.58	2,609	5.81
Dippe	80	3.9	309.3	2,565.6	15,319.59	8.29	16.41	48.91	2,721	5.97
Morrison	18	2.1	37.1	357.5	2,041.22	9.64	15.63	55.04	3,013	5.71
Heine	82	4.2	348.1	2,840.4	16,659.35	8.16	16.08	47.81	2,624	5.86
Rabbetke & Giesecke	82	3.5	288.9	2,268.5	13,614.92	7.85	16.50	47.10	2,591	6.00
Ziemann	81	3.4	274.8	2,084.7	12,935.30	7.59	17.22	47.36	2,614	6.24
Schreiber	103	2.8	292.3	2,249.1	13,469.21	7.69	16.47	46.06	2,533	5.99
Jaensch	93	3.6	333.3	2,524.7	14,061.80	7.58	15.21	42.22	2,306	5.57
Total and average	767	3.85	2,955.6	25,263.7	147,819.06	8.55	16.05	50.01	2,743	5.85

Rocky Ford, Colo.—"Kinds of seeds used: Original Kleinwanzlebener, Schreiber, Dippe, Strandes, Braune, and Heine."

Croswell, Mich.—"We find the Kleinwanzlebener seed to be the best."

Grand Island, Nebr.—"Original Kleinwanzlebener and Dippe Kleinwanzlebener are the kinds of seed used here."

Holly, Colo.—"We have been using Strandes, Kleinwanzlebener, and Dippe seed, tending more toward Strandes seed which has given us the best results."

Lehi and Garland, Utah.—"Varieties of seed used: Kleinwanzlebener, Breustedt, Schreiber, Braune, Kuhn, and Dippe."

REPLIES TO QUESTION No. 12.

Alvarado, Cal.—"The beet soil in use here is a sandy loam."

Janesville, Wis.—"We get the highest tonnage from our old tobacco ground; the highest sugar test from our lighter sandy soil."

Owosso, Mich.—"Our land is clay and clay loam. Dark clay loam gives the best results."

Lansing, Mich.—"The land which we find gives us the best results is a clay loam, tempered with sand sufficiently to place it in a condition where it can be worked easily and to advantage."

Lehi, Utah—Springville Station.—"Sandy loam gives the best results."

Rocky Ford, Colo.—"The heavy sandy loam usually gives the best results."

Saginaw, Mich.—"Best results are secured with clay loam."

Grand Island, Nebr.—"Sandy loam gives best results."

Holly, Colo.—"We have secured the best results from old alfalfa land plowed under a couple of times."

Croswell, Mich.—"We find that black clay loam underlain with a porous subsoil is our best sugar-beet land. It is usually termed black ash and elm land."

REPLIES TO QUESTION No. 13 (GENERAL REMARKS).

Alvarado, Cal.—"No irrigation is used on the company's fields. They depend entirely upon the winter rains. The chief cause of the light crop last season was the blight. In some fields it was quite prominent, mostly on early beets. As the season advanced it showed more than at its first appearance."

Lansing, Mich.—"It is our opinion that, in order to promote this industry and bring it to the condition where it should be, we should reverse the methods which have been employed in the past. We should suit the crop to the farmer and the methods which we find upon the farms rather than endeavor to suit the farmer to the conditions which have been advocated as to the growing of beets. The principal point we would like to make in this connection is that of distance between rows. The trouble has been in the past that beets have been planted too close together. Very few farmers have the implements for the working of beets in rows 20 inches apart and they refuse to buy them; as a consequence we have the general neglect which the beet crop suffers. By planting the beets 28 inches apart we have found that our growers are fitted with a tool which does the work exactly as well as a beet drill and with the two-row riding cultivator such as is used in our district in beans (a favorite crop in our territory), we have a cultivator which does the best class of work and we secure a kind of cultivation which is far superior to that which we secure with a regular two-row beet cultivator. Under these conditions our hand labor costs less, while the tonnage is heavier.

With this mode of cultivation we feel that we are in a position to convince the ordinary farmer that the beet crop is one to be desired on the farm. After having gained this point and made the beet crop a general crop we feel that it would be much wiser to have these same farmers plant their beets 20 inches apart and give them the same kind of care they have given those planted 28 inches. In this way we feel that we can bring the standard of cultivation to the point where it belongs, and in this way increase the tonnage on account of the rows being closer together, and at the same time retain for the crop the good will which we have secured by this method."

Lehi, Utah.—"We have been raising beets for ten to twelve years on the same land. Think it ought to have a change. Will have a system of rotation of crops."

Owosso, Mich.—"We have a large number of farmers who are hauling beets 12 and 15 miles on wagons. One farmer had in 30 acres last year. His average gross receipts were $60 per acre. After hauling the beets 12 miles over roads which were not the best he was well enough pleased to contract for 60 acres another season, claiming that, when his summer work is done, by proper care of the beets—getting them in large piles and siloing them—he

can haul beets when his teams have nothing else to do. This offers the best possible chance for work for him and his horses after the other fall work is done.

We are also in receipt of a report from a farmer who turned 11 head of cattle, young stock, weighing 8,750 pounds all told, in a field after the beets had been topped. These cattle after two months feeding on tops alone weighed 9,510 pounds, a gain of 760 pounds or 8⅔ per cent. This shows what the farmers think of beet tops in this vicinity.

REPORTS FROM STATE EXPERIMENT STATIONS.

In order to gather some information touching the work recently carried on by State experiment stations in States in which the beet-sugar industry has been established, I have kept in close touch with them both by visitation and correspondence. I offer some reports received during the past two years covering some of this experimental work, showing conditions and developments affecting this industry.

CALIFORNIA.

UNIVERSITY OF CALIFORNIA, COLLEGE OF AGRICULTURE,
Berkeley, Cal., January 23, 1906.

Mr. C. F. SAYLOR, *Pasadena, Cal.*

DEAR SIR: Your favor of the 15th instant addressed to the director of this station, has been referred to me. Many of the questions which you ask have no bearing upon the station work. I will, however, take up the matters which have fallen under our observation both in this State and in Colorado.

1. I beg to say that my experience with "irrigating up" beets has not been such as to warrant a favorable opinion of that method of securing a stand, the reason for this being that such treatment does not produce an even stand of beets. Far better results have usually resulted, in my observation, from thoroughly irrigating the land previous to sowing the crop, and depending upon the moisture in the soil for germinating the seed. I can conceive of certain conditions under which it would be absolutely necessary to "irrigate up" the beets, but, as a general practice, I believe it to be unwise, and that the beets should be planted flat rather than in ridges, as there is a tendency for the seed to dry out in some places which do not take water as well as others.

2. Irrigation appears to be most beneficial previous to planting and in the second stage of the growth of the beet—that is, after the form of the beet has been set and it has attained its normal length. If irrigated too early, my observation has been that the beets become rather short and stubby, with a tendency to sprangle, making them undesirable for factory purposes and lessening the tonnage.

3. In this State the conditions are so different from those which exist in most other regions it is almost impossible to get a comparison of climatic conditions in corresponding months. Our rainfall which is of value to the beet crops is that which falls from October to the following March, and, as you probably know, in this State is a very variable factor.

5. Irrigation is practiced here to but a limited extent at present in the production of beets. However, the use of water for this purpose is increasing, and the industry has been saved in the region of Betteravia by the introduction of irrigation by pumping. The aim should be to add to the land enough irrigation water so that a natural precipitation, supplemented by irrigation, should be no less than 20 inches. The general tendency among farmers when they are beginning to irrigate beets is to overirrigate, although in the San Joaquin valley last season the general tendency was to irrigate too little, and not to put the land into proper shape for irrigation.

6. Under separate cover I am sending you a bulletin from our fertilizer division, which will enable you to secure such information as to fertilizer conditions in this State as you may desire.

Yours, very truly, G. W. SHAW.

COLORADO.

STATE AGRICULTURAL COLLEGE OF COLORADO,
DEPARTMENT OF AGRICULTURE,
Fort Collins, Colo., December 27, 1904.

C. F. SAYLOR, *Des Moines, Iowa.*

DEAR SIR: I have your favor of recent date, in which you make inquiry concerning the present status of our work with sugar beets. I will ask Mr. Danielson, my assistant in this work, to give you the results of his experiments with different kinds of fertilizers for growing sugar beets; also, the work we have done with home-grown and foreign-grown beet seed. I am also sending you with this a brief summary of our work last winter with beet pulp for feeding steers. We are now conducting an experiment which we hope will cover the ground a little more throroughly in the way of demonstrating the value of beet pulp for cattle feeding. We have one lot of steers getting nothing but alfalfa hay; another getting all the beet pulp they will eat and alfalfa hay; a third lot getting hay and ground corn; and a fourth hay, ground corn, and beet pulp.

During the past season we had a most excellent crop of beets all over the State. The factory at Grand Junction had a very successful season for beets. This factory had been closed for two years. Yields of beets here last year (1904) were very heavy, the general average being 15 tons per acre, and some going as high as 24 tons. One field of 270 acres averaged 18.9 tons per acre. There is a surprising revival of interest in the growing of sugar beets, and the manager of the factory here has informed me that largely increased acreage is being signed. There is only one doubtful feature in beet growing, and that is the ravages of the leaf worm. It lowered the yield last year on some fields to an appreciable extent. No implements have as yet been thoroughly tested, except a harvesting machine, which was tried in the Longmont and the Windsor districts last year. It was said to be a success, and doubtless will be given a decisive test this year. Our sugar factories are now negotiating for large tracts of land with a view of growing their own beets, to some extent at least, and in this way being more independent of the farmers. I do not know to what extent they will be able to secure this land or just what effect it may have upon the industry.

Trusting that this information will be of value to you,
I am, yours, very truly, W. L. CARLYLE.

NEW YORK.

CORNELL UNIVERSITY, COLLEGE OF AGRICULTURE,
Ithaca, N. Y., December 22, 1904.

Mr. C. F. SAYLOR, *Des Moines, Iowa.*

MY DEAR SIR: Your letter of December 19 at hand. We are not doing very much in investigating the beet-sugar industry. The only experiment we had was the cooperative test in connection with the Bureau of Chemistry, to which beets were shipped weekly. Probably you are familiar with the outline under which this experiment is pursued. We have not issued any bulletins during the past year on this subject. Climatic conditions may be regarded on the whole as favorable. There was trouble in getting a stand, and we had to sow twice. I believe the tendency of thought in the State is that the industry can not be profitably pursued here. One factory (at Binghamton) went out of existence, moving farther west, and I do not know how long the Lyons factory may run. I have no intimate knowledge of their affairs. Personally I feel that three-fifths of a ton of sugar per acre, which is somewhere about our average, is not sufficient to warrant our farmers in growing this crop in competition with western men. This opinion is purely personal, but I think is warranted by the facts. We are trying to encourage the growing of roots, not particularly sugar beets, however, for dairy cattle. We feel that they may replace some of the concentrates in the rations which are now purchased at such a high price from

the West. The dry matter of mangels will run on an average with us about 4,000 pounds per acre, and may be over double this. It it worth about the same as grain—that is, one pound of the dry matter is equivalent to one pound of grain feed—so with corn at $20 to $28 a ton we should have a product worth about $40 to $100 an acre. This work is in the experimental stage. We have conducted rather extensive trials for the main types of roots, and different varieties of these, which will probably be issued in bulletin. This, however, is not sugar investigation, and may not be what you will be interested in.

In regard to sowing sugar beets and methods of cultivation, we have pursued those similar to other years, yields running from 8 to 11 tons of beets per acre. I can not give you the sugar content, as I have not received the same from the Bureau of Chemistry. It would seem that interest in the extensive experiments which were conducted some years ago by this station and the Geneva Station with this crop has cooled off, and that very little is being done at present.

Yours, very truly, S. FRASER.

UTAH.

EXPERIMENT STATION,
Logan, Utah, January 19, 1905.

Mr. C. F. SAYLOR, *Des Moines, Iowa.*

DEAR SIR: The reply to your letter of December 19 has been long delayed owing to my frequent absences from my office. At the present time we are carrying on experiments on (1) the amount of water required for the production of sugar beets; (2) the time to apply the water; (3) the method of applying the water; (4) the effect of various methods of irrigation on the yield and sugar content of sugar beets; (5) the production of beet seed from different varieties of beets grown with different amounts of water; (6) the improvement of the sugar beet by proper selection, breeding, and irrigation. We are also doing some work on the proper fertilization of the sugar beet in the intermountain country.

The work of seed production is carried on in cooperation with the Bureau of Plant Industry of the Department of Agriculture under the direction of Prof. A. J. Pieters. We are also carrying on experiments on the feeding value of beet pulp and yard molasses for hogs, sheep, and milk cows. Some of these results have been published in our Bulletin No. 90, a copy of which I send you under separate cover.

These feeding tests with the sugar beet and beet products are yielding very interesting results. Of course it takes considerable time before definite data are obtained from such work. The results that we have accumulated during the past few years we are now preparing in bulletin form.

The sentiment in the State of Utah is very favorable to the beet-sugar industry. The industry has done a great deal for the State in the way of improving the conditions of our farmers and of bettering the general agricultural practices of the State. There is constant talk of new factories being established, and it seems very probable at the present time that at least two more factories will be erected in the State in time for next season's work. There is also considerable talk among the farmers relating to labor-saving devices that may be used in the production of sugar beets. One or two inventions have already been made in the way of agricultural implements with which, however, I am not familiar. So far as I can judge, the present status of the industry in this State is first class.

I am, very respectfully, yours,

JOHN A. WIDTSOE, *Director.*

WISCONSIN.

UNIVERSITY OF WISCONSIN,
COLLEGE OF AGRICULTURE,
Madison, Wis., December 16, 1905.

C. F. SAYLOR, *Special Agent, Des Moines, Iowa.*

DEAR SIR: Your letter of the 13th instant to Director Henry has been received and referred to me. I take pleasure in sending you, in compliance with your request, a copy of the account of the beet-sugar investigations conducted at our station during the past year (1905). This will go into the 22d annual report of our experiment station, which is now in press.

I do not know that there is much else to be said as regards the situation in this State. The three sugar factories already established have received much larger quantities of beets this year than last, as you will see from the statistics which these factories will be likely to furnish you. The sugar factory here in Madison, which is now in process of construction, will be ready in ample time for next campaign and contracts for acreage are now being signed in the surrounding counties. The factory has a capacity of 600 tons and is built so that it can be enlarged to 1,000 tons by increasing the capacity of the machinery. Everything considered, the prospects for a steady growth of the beet-sugar industry in this State are very bright. The general situation in this State has been discussed at some length by me in our Bulletin No. 123, published last spring.

Respectfully, F. W. WOLL.

[The following is the account of the investigations which Mr. Woll refers to in his first paragraph.]

EXPERIMENTS WITH SUGAR BEETS, SEASON 1905.

By F. W. WOLL, R. A. MOORE, and A. L. STONE.

The industry of growing sugar beets for factory purposes has now become firmly established in this State. One factory has been in operation for four seasons, and during the season of 1904-5 three factories were in operation within the borders of the State, which produced in all nearly twenty-four million pounds of white granulated sugar from about 110,000 tons of beets. In addition, a fourth factory, located across the State line at Menominee, Mich., was supplied with about two-thirds of its beets from Wisconsin farms and produced from these beets about four million pounds of sugar. The prospects for an increase in the number of factories in the State are very bright, one factory being in the course of construction at Madison at the present time and others being contemplated at various places in the State. The general situation as to the Wisconsin beet-sugar industry has been discussed in Bulletin No. 123 of this station. This bulletin is still available for distribution, and will be of interest to farmers who expect to take up sugar-beet culture and become patrons of a sugar factory or who wish to inform themselves as to the situation in this State with respect to the beet-sugar industry.

The work done by this station in the line of sugar-beet experiments during the past season included (*a*) variety and fertilizer tests, and (*b*) growing an acre of beets for the Dane County Sugar Company.

(*a*) *Variety tests of sugar beets.*—The variety and fertilizer tests were conducted on a field one-fifth of an acre in area, located in the rather sloping southwest corner of the experimental plats at the Hill farm. The soil is a light sandy loam which had been reduced to a low state of fertility through continuous cropping by the former owners, no manure having been put on the land for at least ten years past. The east and west quarters of the field were left unfertilized, while the middle half received an application of nitrate of soda, superphosphate, and sulphate of potash, at the rate of 30 pounds of each fertilizing ingredient per acre. The land was plowed in the fall of 1904 and carefully prepared in the spring of

1905 by disking and harrowing in the usual manner for root crops. The fertilizers were put on shortly before planting the seed on May 4. The stand secured was not very satisfactory, in part owing to the planter used, which proved defective. The planter generally used for putting in beet seed was not available at the time. The early part of the season was characterized by frequent heavy rains that washed the ground, in many instances causing the plants to be covered with dirt. Low temperatures also prevailed at this stage of the growing period. In July, and still more during August and September, the weather turned hot and dry, and the drought became extremely severe during the latter month. The relatively small tonnage of beets secured from the plats is doubtless to be traced mainly to this cause.

The varieties of high-grade imported sugar-beet seed planted in these trials will be seen from the following table, which also gives information as to the origin and viability of the seed, weight per hundred seed balls, and number of balls not germinating after fourteen days. The seed of four of the varieties included in these trials was furnished by the various sugar companies doing business in the State at our request for samples of the seed supplied by the management of the factories to their respective patrons.

Results of variety tests of sugar-beet seed, 1905.

Name of variety.	Origin.	Weight.	Germination in—		No. of balls not germinating.
			7 days.	14 days.	
		Grams.			
Hoerning's Improved	Dane County Sugar Co	2.04	95	109	45
Schaefer Grosswanzlebener	F. Dühne, Milwaukee	1.87	77	112	35
Schlandstedt Kleinwanzlebener	do	2.03	133	161	20
Braune Kleinwanzlebener	Chippewa Sugar Co	2.38	169	176	12
Breustedt Kleinwanzlebener	Wisconsin Sugar Co	2.53	140	154	27
Heine Kleinwanzlebener	do	2.18	115	129	29

As already stated, the middle portion of the field was fertilized, while the east and west ends received no fertilizer. All the varieties were, however, under exactly similar conditions in this respect and the results obtained for the entire part of the field planted to the different varieties are therefore given in the following table, which shows the results obtained at harvesting time.

The beets grown on the fertilized portion of the field were sampled September 21 and were analyzed in the chemical laboratory of our station by Geo. A. Olson, assistant chemist, who also made the analyses of the beets sampled at harvesting time. The former set of analyses resulted as follows:

Results of analyses of beets grown on fertilized ground.

	Average weight of topped beets.	Sugar in the beet.	Coefficient of purity.
	Pounds.	*Per cent.*	
Hoerning's Improved:			
North side of plat	1.2	16.30	90.0
South side of plat	1.8	15.10	81.8
Schaefer Grosswanzlebener	1.3	17.07	87.9
Schlandstedt Kleinwanzlebener	.8	16.53	87.6
Braune Kleinwanzlebener	1.0	15.72	79.5
Breustedt Kleinwanzlebener	1.2	17.06	89.4
Heine Kleinwanzlebener	1.9	16.53	89.5

The beets were harvested on October 24 and samples were secured of the beets grown on both the fertilized and the unfertilized portion of each plat. The results of the weighings of the beets and the average analyses of the samples of each variety will be seen in the follow-

ing table, which also gives the calculated yield per acre of beets and sugar, as well as the difference between the individual varieties and the average data for the entire field:

Results of variety and fertilizer tests with sugar beets, Hill Farm, season of 1905.

	Number of rows.	Yield of beets.	Yield of sugar.	Average sugar content.	Average coefficient of purity.a	Calculated yield per acre of—	
						Beets.	Sugar.
		Lbs.	*Lbs.*	*P. ct.*		*Lbs.*	*Lbs.*
Hoerning (plat south)	3	334.3	55.87	16.7	88.2	12,257	2,048
Hoerning (plat north)	3	288.0	47.37	16.4	91.4	10,560	1,737
Schaefer	4	496.5	86.40	17.7	89.9	13,378	2,376
Schlandstedt	4	555.0	93.39	16.5	89.0	15,537	2,568
Braune	4	476.0	83.81	17.6	90.2	13,090	2,304
Breustedt	2	284.2	48.91	16.8	91.2	15,631	2,690
Heine	2	270.6	46.09	17.0	86.5	14,883	2,634
Totals and averages	.....	2,704.6	461.84	17.0	89.6	13,619	2,337

a Arithmetical mean.

The figures for the calculated yields of beets in the preceding table show that the average for the entire field was less than 7 tons per acre and that of the calculated yield of sugar per acre was 2,337 pounds. The lowest yield of beets was obtained from the northern plat planted to Hoerning seed, viz, at the rate of 10,560 pounds of beets per acre, and the highest yield, 15,631 pounds, was obtained from Breustedt Kleinwanzlebener seed. The yields of beets, as well as of sugar from Breustedt, Schlandstedt, and Heine were above the average for the entire field, and the yield of sugar in the case of the Schaefer seed was also somewhat above average. The sugar content of the beets grown from seed of different origin ranged from 16.4 per cent (Hoerning, north plat) to 17.7 per cent (Schaefer). The beets grown from the latter variety and from Braune seed were the only kinds that contained more sugar than the average for the entire field. These two varieties with Hoerning (north plat) and Breustedt, were also above average in purity. In the case of all these varieties it will be seen, however, that both the sugar contents and the purity of the beets were exceptionally high, so that no serious criticism could be offered even with regard to the varieties showing the lowest results. The largest calculated yields of sugar per acre were obtained from the Breustedt, Heine, and Schlandstedt beets in the order given, and it will be seen that these three varieties gave considerably higher returns in sugar per acre than the beets grown from seed of other origin which was included in these trials.

(*b*). *Fertilizer trials.*—The trials were planned so that they might furnish information in regard to the effect of an application of a complete fertilizer, containing nitrate of soda, sulphate of potash, and acid phosphate, on the yield and quality of beets grown on the land. Plats A and C of the field did not receive any fertilizer, while the center half of the field, plat B, was fertilized, as previously stated. The same varieties of beets were grown on these plats, so that the data obtained furnish information as to the effect of the fertilization. The results obtained have been summarized and are given in the following table:

Results of fertilizer trials with sugar beets, season of 1905.

	Unfertilized plats.			Fertilized plat B.	Increase due to fertilization.	
	Plat A.	Plat C.	Plats A and C.			
	Pounds.	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Per cent.*
Yield of beets	387.0	730.8	1,117.8	1,586.7	+ 468.9	+41.9
Yield of sugar	63.11	123.66	186.77	275.07	+ 88.30	+47.3
Average per cent sugar	16.3	16.9	16.7	17.3	.....	+ 0.6
Average purity	87.9	90.3	89.1	90.2	.....	+ 1.1
Calculated yields per acre:						
Beets	7,740.0	14,616.0	11,178.0	15,867.0	+4,689.0	+41.9
Sugar	1,262.0	2,473.0	1,867.7	2,750.0	+ 883.0	+47.3

It will be noted that there was a marked improvement both in the yield and the quality of the beets grown on the fertilized half of the field as compared with the results for either of the end plats, which received no fertilizers. The average yield of beets secured from the field was small, but the quality of the beets was excellent, the average sugar content of the beets on the unfertilized plats being 16.9 per cent and on the fertilized plats 17.3 per cent, the average purity on the unfertilized plats being 89.1 and on the fertilized plat 90.2. Through the application of fertilizers the yield of beets was increased by 41.9 per cent and the yield of sugar per acre was increased by 47.3 per cent over the corresponding figures for the unfertilized plats. On account of the low yield secured in these experiments, computations in regard to the economy of using fertilizers would be of no special value. There can be no question, however, that applications of artificial fertilizers for sugar beets will amply pay on poor land like that used in these trials under ordinary conditions, when a good stand and at least a medium yield of beets are obtained.

Sugar beets for factory purposes.—An acre of beets was grown at the University farm during the past season under contract with the Dane County Sugar Company. The soil is a clay loam, toward the west quite rich in humus and not well drained. The land has been in pasture for several seasons past and was in a good state of fertility. It was plowed in the fall of 1904 and received treatment similar to the beet field on which the variety tests during the past season were conducted. The dates of planting, cultivation, laying by, etc., also corresponded quite closely with the respective dates for that field. The seed used was Hoerning's improved of the same stock as that planted in the variety tests.

The first sampling of the beets took place September 21, when it was found that the average weight of the topped beets in the large sample taken was 0.66 pound, the average sugar in the beet being 15.18 per cent and the average purity 88.7.

The ratio of tops to roots was 1:98. At harvesting time three samples were taken from different parts of the field, which were found to contain 16.52, 17.38, and 16.34 per cent of sugar, with purities of 90.7, 88.3, and 87.1, respectively. The averages of these figures—16.75 and 88.7—may be taken to fairly represent the sugar content and the purity for the entire field.

The yield of beets from the field was 23,065 pounds and the yield of sugar per acre, therefore, about 3,863 pounds. For the sake of comparison the average results obtained at our university farm in growing sugar beets during eleven seasons, 1890–1904, are given below.

Average results obtained in growing sugar beets, university farm, 1890–1904.

	Calculated yield per acre.		Average sugar content.
	Beets.	Sugar.	
	Tons.	*Pounds.*	
Average eleven seasons	17.37	4,900	14.10
Maximum results	[a] 29.94	[a] 8,213	[b] 16.9
Minimum results	[c] 7.34	[d] 2,503	[c] 11.8
Season 1905	11.53	3,863	16.75
Average for twelve seasons, 1890-1905	16.88	4,818	14.26

[a] 1902. [b] 1892. [c] 1891. [d] 1897. [e] 1903.

Owing to the unfavorable weather conditions during the past season the yield of beets secured was considerably below the average for the preceding eleven seasons, but the yield of sugar was nearly up to the high average reached during the earlier years, from the fact that the average sugar content of the beets was over 2½ per cent above the general average for the period during which these experiments have been conducted.

SUGAR-BEET INVESTIGATIONS IN 1905.

CONDUCTED BY THE BUREAU OF PLANT INDUSTRY.

LETTER OF SUBMITTAL.

U. S. DEPARTMENT OF AGRICULTURE,
BUREAU OF PLANT INDUSTRY,
Washington, D. C., April 14, 1906.

SIR: I submit herewith for publication as part of the report on the "Progress of the Beet-Sugar Industry for 1905" a very brief account of the progress that has been made in certain lines of investigation carried on by experts of this Bureau relating to the growing of sugar-beet seed, the fertilization of sugar-beet crops, and the diseases affecting the crop. It should be noted that on none of these lines has the investigation progressed far enough to justify definite general conclusions.

Respectfully,

B. T. GALLOWAY,
Chief.

Hon. JAMES WILSON,
Secretary of Agriculture.

SINGLE-GERM BEET SEED.

The publication of Bulletin No. 73 of the Bureau of Plant Industry has placed before the beet growers and experiment-station workers a description of the methods employed and the progress made in the attempt to produce the so-called single-germ beet seed. The value of this production, if accomplished, would be very great in view of the reduction of labor which would be brought about in the thinning of the beets. The reports issued by the Bureau state that the work has now progressed to a point where strains of beets have been secured which produce approximately 25 per cent of single-germ seed. This indicates very strongly that the experiment will be a success. Tests made with beets grown from single-germ seed the past season show that the sugar content of the beets is fully up to the standard.

DISEASES OF THE BEET.

During the past season, as in previous years, two diseases of sugar beets were especially serious. In the eastern United States the eastern blight or leaf spot has in many places done considerably more damage than the growers realize. It has been shown that this disease mate-

rially reduces the tonnage as well as the sugar content of the beets, both by destroying leaves which would otherwise produce sugar and by forcing the beet to produce an additional number of leaves. The Department's work has shown that this disease may be prevented by spraying with Bordeaux mixture in very much the same way as spraying is carried on for potatoes. In the Rocky Mountain areas and on the Pacific coast the most serious disease has been the so-called curly top. No definite cause for this trouble has yet been worked out. The most important observation in connection with it is that it rarely occurs twice in the same place consecutively; thus if the disease is bad in a field this year it is almost certain that it will not appear in the same field next year. Although the trouble is probably due to some peculiar combination of unfavorable conditions of soil and climate, the particular combination has not yet been discovered.

FERTILIZERS FOR SUGAR BEETS.

For several years efforts have been made to increase the yield of beets by the application of various forms of fertilizers. The Department has tested green manures, stable manures, and commercial fertilizers. However, nothing additional to what was said in the report for 1904 can be reported.

THE PRODUCTION OF SUGAR-BEET SEED.

The work on the establishment of commercial sugar-beet seed growing has been carried on with reference to three problems: (1) The production of pedigree commercial seed; (2) the testing of American-grown seed in comparison with the best strains of European seed, and (3) the effect of soil and climate on the value of sugar-beet seed for conditions similar to those under which it was produced.

COMMERCIAL PRODUCTION OF PEDIGREE SEED.

To grow sugar-beet seed commercially, certain conditions are necessary which do not always apply to experimental work. It is necessary not only that seed of high quality be grown, but also that it be grown economically and that there be reasonable certainty of a crop. The climatic conditions at the time of harvesting are therefore of the utmost importance and may even be the determining factor in the successful production of seed in this country. While the experimental work may determine that seed of high quality can be grown in the eastern United States, it is possible that the uncertainty of the weather during the time of harvesting may render sugar-beet seed growing practically out of the question except in the Western States, where the summers are dry. This matter will, of course, be determined during the investigation. As soon as the Department is satisfied that sugar-beet seed can not be economically produced in the

Eastern States, experiments along that line will be discontinued. At present, however, the work of producing pedigree seed is being conducted in the States of New York, Michigan, Utah, and Washington; the two former represent typical eastern conditions, and Michigan represents a State in which the sugar-beet crop is an important one; the State of Utah represents conditions under which beets must be grown with irrigation, and the State of Washington represents conditions more nearly comparable to those in the Eastern States, except that the weather during the harvesting period of the seed is more certain.

So far the commercial production of sugar-beet seed has been practically confined to Utah and Washington States, and the seed grown in Utah has been very little used outside of that State. The seed grown in Washington State, while not from pedigree beets, has given general satisfaction wherever used and has proven superior to the average grade of factory seed imported from Europe. During the summer of 1904, which is the latest for which we have complete returns, this Department distributed 13,962 pounds of American-grown sugar-beet seed, by far the largest amount being Washington-grown. This seed was sent to farmers who were growing beets for the factories, and was therefore tested in direct comparison with the factory seed. These tests were carried on in 13 States and on 153 farms in these States, the entire area covering 564 acres. The results gave an average yield for the Washington-grown seed of 10.72 tons per acre, taking all States together, as against an average of 9.92 tons harvested from an equal area raised from factory seed. The sugar content of the Washington-grown seed averaged 15.41 per cent, while that from beets from factory seed averaged 15.26 per cent. Stated in another way, the American seed yielded, roughly, from 300 to 350 pounds of sugar per acre more than the imported seed.

The work of developing a strain of pedigree seed has gone far enough so that we shall be able to grow commercial crops of seed from these pedigree beets. When this is done, it is expected that a considerable improvement will be apparent over the original commercial seed. Some of the mother beets that have been used to establish lines of breeding have tested more than 24 per cent sugar and have at the same time been of good average weight—a pound and a half and over. The seed from such individual mother beets is carefully planted and the beets grown from it again selected and tested. This course determines which of these mother beets has the power to transmit its qualities. The progeny of such a beet—that is, one which is at the same time of high quality and has the power to impart that high quality to its descendants—is then used to establish a line of breeding.

TESTING AMERICAN-GROWN SEED.

The testing of American-grown sugar-beet seed in comparison with various strains of European seed has given results practically identical with those above referred to. In this work, of course, it was not always factory seed that was used, but often seed that was received from European growers for test. Such seed was presumably of the best quality. Samples of European seed have been secured which gave higher yields than was secured from the American-grown seed, but such samples also were very far in advance of the seed supplied to factories.

EFFECTS OF ENVIRONMENT.

It is contended by many European growers that sugar-beet seed should be raised under conditions under which the beets themselves are to be grown for the factory. If this is true, it means that factories in Michigan ought to use seed grown in Michigan; those in Nebraska, Nebraska-grown seed, and those in Utah, Utah-grown seed, and so on. The Department is working to solve this problem, but it must be remembered that from a practical standpoint the question is not only whether Michigan-grown seed will give a higher yield than, let us say, Washington-grown seed in Michigan, but whether this higher yield, if secured, will be sufficient to pay the higher cost of the seed due to the greater expense of raising it and the frequency with which the seed crop will be injured by rains during the harvesting season. So far as our experiments have gone, they do not indicate that seeds grown in Michigan or in New York from carefully selected beets give any better results in these States than seed grown from equally well selected beets grown in Washington State. It was also found that Michigan-grown seed did not give any better results in Michigan than it did in any other States in which our experiments were conducted. On the contrary, the Washington-grown seed has so far proved the best everywhere.

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U. S. DEPARTMENT OF AGRICULTURE.

Report No. 83.

REPORT

OF THE

SECRETARY OF AGRICULTURE.

1906.

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U. S. DEPARTMENT OF AGRICULTURE.

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REPORT

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REPORT

OF THE

SECRETARY OF AGRICULTURE.

Mr. PRESIDENT:

In presenting my Tenth Annual Report of the work of the Department of Agriculture, the position of the producer from the soil in the development of our country is indicated.

It will be seen that he is making progress in the sciences and arts of agriculture; that the researches of the Department and of the experiment stations are enabling him to meet the requirements of a growing population for larger quantities of field products; that the time of the man and the yield of the acre become more responsive as more imperative demands are made upon them; that our research extends to all the States and Territories and to our island possessions; that every feature of interest in soils, plants, and animals has due attention; that explorations during the past year in extreme northern latitudes of Europe and Asia have resulted in accessions of plants suitable to our dry regions that promise to help in bringing them into profitable production.

The laws made by Congress at its last session to be put into execution by the Department have required and have received special attention. The meat law is being enforced with but little friction. At this time inspection is made in about 1,000 houses, and about 1,300 experts have been added to the inspection force of the Bureau of Animal Industry.

Rules have been made, as required by Congress, for the execution of the pure-food law, and hearings are being given to parties interested. The law requiring the extermination of the cattle fever tick (*Boophilus annulatus*) of the Southern States is being put in force and good results are following. Progress is being made in dealing with the gipsy and brown-tail moths in New England, imported parasites being successfully established. A beginning has been made in determining correct rules for grading grain and acquiring facts regarding methods of handling it in its movement toward the market.

The law providing for the humane treatment of live stock in transit is receiving careful consideration, and violations will be reported to the Department of Justice.

REVIEW OF PRODUCTION.

NATIONAL DEPENDENCE ON AGRICULTURE.

Economic revolution in the art and science of agriculture, which became noticeable in this country half a dozen years ago, has continued during 1906, with tremendous effect upon the nation's prosperity.

Crops so large as to be beyond any rational comprehension have strained the freight-carrying ability of railroads. Directly and indirectly the farmer has set up a demand for iron and steel that has

exceeded the productive power of the chief producer among nations. His contribution to the supply of loan capital has been beyond calculation and recalls the fact that the depression in the loan and investment mark t of 1903 was cleared away by the following crop.

Meanwhile the farmer has been a generous consumer, and has given powerful support to the market of the industrial producer, to the trade of the merchant, and to the wages of the workingman.

The farmer has become aware of the importance of the place that he occupies in the Republic, and in the pride of his occupation he is ready to offer this yearly account of himself to the people.

Preliminary crop estimates, subject to modification, must be used in the following review of the year's farm production, in advance of the final estimates of the Department, to be made a little later. The estimate of total agricultural wealth production has been continued from previous years and is again presented as an indication of the financial results of the year's operations. All attempts in the past, by subtracting from this grand total of value such products as are used wholly or in part in the making of other farm products in order that the farmer's net wealth production might be ascertained, have given no indication of what that net production was and have only obscured the matter.

TOTAL WEALTH PRODUCED.

Taken at that point in production at which they acquire commercial value, the farm products of the year, estimated for every detail presented by the census, have a farm value of $6,794,000,000. This is $485,000,000 above the value of 1905, $635,000,000 above 1904, $877,000,000 above 1903, and $2,077,000,000 above the census for 1899.

The value of the farm products of 1906 was 8 per cent greater than that of 1905, 10 per cent over 1904, 15 per cent over 1903, and 44 per cent over 1899.

A simple series of index numbers is readily constructed, which shows the progressive movement of wealth production by the farmer. The value of the products of 1899 being taken at 100, the value for 1903 stands at 125, for 1904 at 131, for 1905 at 134, and for 1906 at 144.

GAINS AND LOSSES.

Analysis into items of the grand total of wealth produced discovers that most of the increase over 1905 is due to horses and meat animals, and this is so partly because of the Department's much increased estimate of the number of these animals last January, and more largely because of higher prices than a year ago.

The price of milk ran higher than in 1905, but the value thus gained in wealth produced was perhaps more than offset by the lower prices for butter. So, in the case of poultry, the gain in live and drest poultry was more than balanced by the reduced egg value, since the mean farm price of eggs, as ascertained by this Department, declined from 18.7 cents during 1905 to 17 cents during 1906.

Crops, in a general balance of gain against loss in value, in comparison with the crops of 1905, have made substantial but not large gain—about $22,000,000; so that the previous foremost year in value of products, 1905, is exceeded by 1906 in both crops and animal products, and thus this year became the leading one in value of farm products in the history of the country by $485,000,000 over 1905.

On the side of gains over 1905, two short crops are conspicuous; hay leads with a gain of perhaps $80,000,000 in value, and the oat crop is second, with a gain of possibly $14,000,000. Barley and cotton-seed each promise a gain of $10,000,000; beet sugar, $7,000,000; tobacco, $2,000,000 or more; and hops, $1,000,000.

Against these gains are the losses of three abundant crops—$60,000,000, more or less, for wheat, and $10,000,000 each for corn and potatoes. The loss on rye and cane sugar may be about half a million dollars each, if anything. The net decline for all cereals may be $40,000,000.

The foregoing gains and losses in value, as well as others not mentioned, are exceedingly uncertain, and are to be regarded only as indicative of a general conclusion.

CHIEF CROPS.

ALL CEREALS.—While the value of all cereals dropt about $40,000,000 below the total of 1905, and about $12,000,000 below the total of 1904, the number of bushels for 1906, which was 4,688,000,000, was 120,000,000 bushels above the yield of 1905, 570,000,000 above the yield of 1904, and 835,000,000 bushels above the yield of 1903.

CORN remains by far the most valuable crop, and the figure that it may reach this year is $1,100,000,000 for 2,881,000,000 bushels—perhaps a little under the value of the next largest crop, that of 1905.

THE COTTON CROP, fiber and seed combined, follows corn in order of value, altho it is only three-fifths of the value of the corn crop. No comments here must be regarded as indicating what the Department's estimate of the cotton-fiber production is to be. Upon the basis of the general commercial expectation of a crop, it should be worth to the grower nearly $640,000,000. In Texas alone the cotton crop is greater than that of British India and nearly three times that of Egypt, and it is half as much again as the crop of the world, outside of the United States, India, and Egypt.

HAY is a crop that receives small popular attention, and yet it is the third one in value if cotton seed is included in the cotton crop, and this year it approaches $600,000,000 for a product that is short by perhaps 8,000,000 tons.

WHEAT.—The fourth crop in order of value is wheat, which this year may be worth over $450,000,000, a value that has been exceeded in several years; but in quantity this year's crop, with its 740,000,000 bushels, is only 8,000,000 bushels below the largest crop grown—that of 1901.

OATS.—The crop of oats, on account of unfavorable weather, has fallen below the usual amount, but its value will be perhaps not far under $300,000,000, or about the same as for 1905, and not much under the highest value reached, in 1902.

POTATOES.—With a probable crop of fully 300,000,000 bushels potatoes reach next to their highest production, which was in 1904; but the total value, $150,000,000, rests upon a rather low average per bushel and has been exceeded in other years.

BARLEY.—Seventh among the crops in order of value is barley, a cereal that has gained 21 per cent in production in seven years. The 145,000,000 bushels grown this year may be worth $65,000,000, both bushels and dollars being much more than for the highest preceding years—1904 being the previous record year for yield and 1902 for value.

TOBACCO, which has shown weakness for several years on account of low prices, while not yet recovering its former place in pounds grown, has a crop this year of 629,000,000 pounds, with a value which is in close company with the three years of highest value, and it is expected will be worth $55,000,000, or perhaps $2,000,000 more.

SUGAR.—A remarkable development has been made within a few years by now the ninth crop—beet sugar. The production in 1906 is placed at 345,000 long tons, with a value supposed to be near $34,000,000. Seven years ago only 72,972 tons were produced, and their value was about $7,000,000.

The year was a rather bad one for cane sugar, but in spite of this the total production of beet and cane sugar slightly exceeded the highest previous figure, altho in value of sugar the year stands second. The value of all kinds of sugar, sirup, and molasses reaches a total of $75,000,000, second only to 1904, which was cane sugar's best year.

FLAXSEED.—The 27,000,000 bushels of flaxseed have been exceeded by three years, altho the value, $25,000,000, reaches the highest point.

RICE, standing twelfth in order, is another crop with its highest value, perhaps $18,000,000, altho in production the 770,000,000 pounds of rough rice are second to 1904. Markets that have developed in Hawaii and Porto Rico have helped to keep the price high enough to account for the total value placed upon the crop.

RYE has become a minor crop and has now fallen below rice in value. The crop of this year is below the larger crops of recent years, and is about 28,000,000 bushels, worth perhaps $17,000,000.

HOPS.—The fourteenth crop is hops, which reached its largest dimensions this year with 56,000,000 pounds, and as high a value as it ever had, except in 1904, say, $7,000,000.

SUMMARY.—On the whole, crop values have been neither notably high nor low in comparison with recent years, but the crops are so many in number that losses meet gains, and the crops have been on such a high price level in the general average that they have raised the total crop value somewhat above 1905 and the high preceding years. To reach a still higher point in this extraordinary series of high annual values than had been touched before is an achievement that deserves attention.

EXPORTS OF FARM PRODUCTS EXCEED FORMER YEARS.

Farm products continue to be so far beyond the national requirements that the farm still overshadows the mill, the factory, and the workshop in providing exports. With his surplus beyond the nation's need, the farmer has loaded the fleets of oceans. These products were exported to the value of $976,000,000 during the fiscal year ending June 30, 1906—enough to build a high-class railroad halfway around the earth. This is the largest amount ever reached by agricultural exports for this or any other country, and exceeded by $24,000,000 the extraordinary value of 1901, which had previously been the record year.

PRINCIPAL ITEMS.

Principal among the items that make the increase over the fiscal year 1905 are grain and its products, chiefly wheat and flour, for which the gain was $79,000,000; packing-house products, for which the gain was over $37,000,000; cotton, $19,600,000; various seeds,

$6,355,000; dairy products, $3,900,000; and live animals, $2,400,000. Products exhibiting a decrease were mostly inconsiderable. In hops, the decline was $1,355,000; tobacco, $992,000; vegetable oils, $726,000; fruits, $440,000.

HIGHEST VALUE OF COTTON EXPORTS.

Cotton maintains its long lead over other chief exports, with a value of $401,000,000 for 3,634,000,000 pounds, so that the latest year was exceeded only by 1898, 1899, and 1905 in quantity exported; but in value of exported cotton the figures for 1906 are $19,600,000 higher than for 1905, which was previously the record year, and $29,000,000 higher than for 1904, which was third in order in the value of these exports.

In exports of grain and grain products for 1906 the value again reached a high amount and has been exceeded only 13 times in the last fifty-six years. The value of this class of exports last year was almost exactly the average of the preceding twenty-five years.

LEADING YEAR FOR PACKING-HOUSE PRODUCTS.

Packing-house products are another class of exports that found their leading year in value in 1906, the amount being $207,700,000. No previous year had reached $200,000,000, and only two years had past $180,000,000. The value of exported fresh beef, $24,300,000, was well up to the average of recent years; lard exports to the value of $60,000,000 and a quantity of 742,000,000 pounds went far beyond the highest figure of preceding years in both respects; bacon took an upward turn with exports valued at $36,000,000 for 361,000,000 pounds and rose well up toward the higher export years of the past. The level of recent years was reached in the exports of hams, their value being $20,000,000 and weight 194,000,000 pounds. The highest exports, both in quantity and value, of oleo oil in previous years were far overtopt by the exports of this commodity in 1906, and the 210,000,000 pounds exported were valued at $17,500,000.

IMPORTS OF FARM PRODUCTS.

The imports as well as the exports of agricultural products reached their highest value in 1906, when the amount was $554,000,000, or less than one-fourth of a million dollars over the value of 1905, which was then the highest record. The principal increases over 1905 in these imports were $20,000,000 for packing-house products, almost entirely composed of hides, skins, hair, and bristles; $4,400,000 for tobacco; $2,700,000 for vegetable fibers; $1,900,000 each for seeds and vegetable oils; $1,800,000 for fruits; $1,200,000 for nuts; and $1,100,000 for vegetables. On the other hand, there were decreases in imports which nearly balanced the increases, and principal among these were coffee, with a loss of $11,000,000; sugar and molasses, with a loss of $12,600,000; wool and silk, with a loss of $7,000,000 each; and tea, with a loss of $1,650,000.

The principal imported articles are the same year after year, and among them for 1906 the imports of packing-house products were valued at $96,000,000; of sugar and molasses, $86,000,000; of coffee, $73,000,000; of silk, $54,000,000; of vegetable fibers, $50,000,000; of wool, $39,000,000; of tobacco, $22,000,000; of fruits, $21,500,000; of tea, $14,600,000; and of vegetable oils, $12,600,000.

FOREIGN TRADE IN FOREST PRODUCTS.

On account of the increasing value of forest products, the exports of these commodities in 1906 reached a considerably higher figure than ever before, with a value of $77,000,000, or $13,748,000 more than in 1905. The imports of these products also increased in value by $3,000,000; all items exhibit an increase except india rubber, the imports of which declined by $4,800,000. In total value the imports of forest products were $95,700,000 in 1906, an amount far above that of any preceding year except 1905.

BALANCE OF TRADE.

The so-called balance of trade in the international exchange of agricultural commodities continues to run in favor of this country by an enormous amount; for 1906 the agricultural exports exceeded similar imports by $433,000,000, an amount which places this year with the seven high years beginning with 1898 and much above the balance of 1905. This new foreign credit, which equaled that of a rich nation, was mostly offset by large borrowings in this country from Europe for the purpose of enlarging railroads and other capital.

While the farmer placed to the National credit in other countries $433,000,000 in 1906, other producers, all included, secured a balance in favor of this country of only $85,000,000. During the last seventeen years the farmer has built up a balance of trade in foreign exchange of agricultural products amounting to $6,068,000,000, while all other producers find themselves at the end of the same period with a total on the debtor side of the account to the extent of $459,000,000.

INCREASE OF FARMING CAPITAL.

Having produced fabulous wealth during the year and having sent to foreign countries out of the wealth of the preceding year enough to pay the interest-bearing national debt, the farmer may now take account of his farming capital. The large rate of increase in its value since 1900 is not a mere matter of a higher price level and higher land values. In the meantime the farmer has earned a surplus income, much of which he has invested in his farming equipment, in buildings, in many improvements, in live stock, in machinery, and in furtherance of the comforts and pleasures of living.

REAL ESTATE AND FARM EQUIPMENT.

The farm real estate, as ascertained by this Department last year, increased in value $6,131,000,000 since the census year, or enough to raise the census value to $22,745,000,000. Domestic animals were worth $2,979,000,000, according to the census enumerators, and now they are estimated to be worth more than $4,000,000,000. There has been a very active demand for implements and machinery, not only by farmers who have become financially able for the first time to buy, as in the South, but by farmers already provided with them, who have needed to reduce their dependence upon human labor by getting more serviceable machines.

If real estate, domestic animals, other live stock, and implements and machinery are combined, the farmers' capital, as composed of these items, has increased by perhaps $8,000,000,000 since the census valuation, or about 40 per cent, and now amounts to perhaps $28,000,000,000.

DOMESTIC ANIMALS.

The domestic animals of the farm number about 200,000,000 at the time for which it is estimated by the Department, which is January 1. Strictly beef cattle, sheep, and swine are each one-fourth of the total, and dairy cows and draft animals each about one-tenth. The value of these animals has increased during the year, and only a very rough estimate can now say how much, in advance of the careful estimate to be made in January. Perhaps the gain is about $400,000,000; at any rate, the increase seems to be as much as 10 per cent.

MEAT SUPPLY.

NUMBER OF ANIMALS SLAUGHTERED.

Upon the farmers' vast herds of meat animals the nation depends for its most expensive class of foods in various kinds of meat and for one-third of its dietary. The figures of meat production, which are the result of a recent large and searching investigation by this Department, strikingly express the magnitude of the farmer's occupation, as evidenced by only one of its branches, and the largeness of its performance in national sustenance and exports.

In the last census year, 1900, 93,502,000 meat animals were slaughtered and exported, and of these 18,809,000 were cattle, including calves; 24,548,000 were sheep, including lambs; and over one-half, or 50,145,000, were hogs. Every time the clock ticks a second during ten hours of a workday the farmer drives nine meat animals to the butcher.

POUNDS OF MEAT PRODUCED.

The meat production of 1900, in terms of drest weight and weight of edible parts not included in drest weight, was 19,186,330,000 pounds, of which 2,433,035,000 pounds, or 12.68 per cent, were exported, so that the national consumption was 16,753,295,000 pounds.

Such great numbers may be better understood if they are reduced to the average of the census private family, 4.6 persons. To such a family in 1900 the farmer supplied 49 pounds of veal, 431 pounds of beef, 30 pounds of lamb, 39 pounds of mutton, and 465 pounds of pork, including lard, or, in all, 1,014 pounds of meat, amounting to half a ton.

If the exports had been consumed at home, they would have given to each family more beef than the foregoing by 50 pounds, more pork by 97 pounds, or together 147 pounds.

In the consumption of meat, exprest in terms of entire animals, each family asks the farmer for over one-third of a calf, over two-thirds of a steer or cow, over three-fourths of a lamb, nearly three-fourths of a sheep, and two and one-half hogs, and the farmer responds so liberally that one-eighth of his supply is left over for the foreigner. It is upon the selling of this surplus in foreign countries that the farmer depends for the maintenance of profitable prices for his meat animals.

LARGE PLACE OF THE SURPLUS IN THE WORLD'S TRADE.

This fraction of one-eighth is small, but it becomes remarkably magnified when it crosses the Atlantic Ocean. The national surplus of meat for one year, if composed of the different kinds as actually

used in consumption, is sufficient to feed either the United Kingdom or the German Empire for nearly half a year, or both for nearly one-fourth of a year, and the population of these two countries in 1901 was 98,000,000, as compared with a population of 76,000,000 in this country the year before.

This little fraction of the national product of meat which goes to other countries looks large when viewed in another aspect. In the world's international trade in packing-house products and live meat animals the place occupied by the exports from the United States is indicated by about 40 per cent of the total value.

IMPORTANCE OF SWINE.

As a meat producer, the importance of the hog appears in the foregoing statement. The yearly turnover or slaughter of hogs is equal to about four-fifths of the number on hand June 1, and the meat, including lard, produced in 1900 was 9,279,583,000 pounds, or more than half a billion pounds over the 8,771,263,000 pounds of veal and beef, and over eight times the 1,135,484,000 pounds of lamb and mutton.

In one State alone, Iowa, the pork products for 1906, including lard, are equivalent in pounds to nearly the entire exports of the meat products of swine in 1900. Should Iowa suddenly lose its swine, for the time being exports of their products must substantially cease or the home consumption of them be reduced one-fifth.

Briefly mentioned, such are some of the main results of the Department's investigation of the meat supply. They indicate the proportions of the part that the farmer of this country takes, in only one direction of his work, as a provider of meat to now 85,000,000 fellow-countrymen and to the rest of mankind.

CONSUMERS' YEARLY MEAT BILL.

Meat consumers, as well as farmers who are meat producers, have concern with the national dietary. This nutritive element contributes one-third or more of the total assimilated nutrients of the dietary, both in pounds of protein, or flesh-forming material, and in calories of energy. In expense to the consumer the fraction is undoubtedly much larger. The investigations of the National Bureau of Labor into the retail prices of food indicate, for the many representative family budgets included in the investigations, that the average retail price of meat, for all kinds in the proportions of actual consumption, was 12¾ cents in 1900, 13 cents in 1901, and 13½ cents in 1905; the average increased, perhaps, to 13¾, or at the most to 14, cents in 1906.

At these average meat prices and with the meat consumption of 1900, the national retail meat bill was $2,052,279,000 in 1900, and it was $2,303,578,000 to $2,345,461,000 in 1906. Every increase of one-fourth of a cent per pound in the national average retail price of meat raises the total yearly expense to consumers by $41,883,000. The increase of one cent a pound since 1900 cost consumers this year $167,533,000.

FUTURE PRODUCTION.

FAULTS OF THE PAST.

The mighty production of the farm for one-third of a century has come out of an agriculture having many faults. In a large degree there has been one-crop farming; crop rotation, as practised, has often

been too short and unwise; the grasses and leguminous forage crops have been neglected, domestic animals have not sufficiently entered into the farm economy, and many dairy cows have been kept at a loss. The fertilizers made on the farm have been regarded as a nuisance in some regions; they have been wasted and misapplied by many farmers; humus has not been plowed into the ground as generally as it should have been; and in many a place the unprotected soil has been washt into the streams.

ECONOMIC JUSTIFICATION.

This, in few words, is the historic story of agriculture in a new country; yet the course of agriculture in this country, bad as it may seem in its unscientific aspect, has had large economic justification. While pioneers, poor and in debt, are establishing themselves they have no capital, even if they had the knowledge, with which to carry on agriculture to the satisfaction of the critic. They must have buildings, machinery, and live stock, even at the expense of the soil.

Millions upon millions of acres of fresh land have been coming into production faster than domestic consumption has required, and, at times, beyond the takings of importing countries. For many years the farmer was threatened with 40-cent wheat, 20-cent corn, and 5-cent cotton, and at times he was face to face with the hard conditions implied in these destructive prices. A more scientific agriculture would have raised wheat that no one wanted to eat, corn to store on the farm and perhaps eventually to be used for fuel, and cotton not worth the picking.

LARGER PRODUCTION INDICATED.

So it has happened, with reason, that the production per acre has been low; but there is no likelihood that low production is fixt and that the farmer must continue his extensive system. When consumption demands and when prices sustain, the farmer will respond. The doors of knowledge and example are opening wider to him.

There is abundant information concerning crop rotation, the dependence of high production upon the domestic animals, concerning grasses, clover, and alfalfa, and concerning the mixing of vegetable matter with the soil. Systems of farm management and soil treatment have assumed greater importance in their effect upon production; and there is the breeding of plants, which alone can multiply production so as to glut the market.

MULTIPLICATION OF THE COTTON CROP.

If there were need to do so, the cotton farmer and planter could double the present crop of two-fifths of a bale per acre, and the feat would need nothing more than demonstrated and well-understood principles of farm management. It would be no work of magic to multiply the production of cotton per acre by 3 and get a bale and a quarter; and, besides this, the planter has more than three times the present actual acreage in cotton readily available and awaiting his use. More than the present area of cotton can thus be grown in a three-year crop rotation when the needs of the world demand it.

INCREASE OF CORN.

In accordance with principles demonstrated, known, and applicable, hints of which have been given, the corn crop per acre can be increased by one-half within a quarter of a century, and without any pretense that the limit has been reached. No wizard's services are needed for this, but just education.

MORE WHEAT PER ACRE.

The same statement is applicable to wheat. There is no sensible reason why half as much again wheat may not be had from an acre within less than a generation of time. It is only a question of knowledge, of education, of cultural system, and of farm management, all of which learning is and will be at the service of the farmer as he needs it.

GAIN IN OTHER CROPS.

Equally feasible is a 50 per cent increase in the crops per acre of oats, barley, rye, and buckwheat. Potatoes, instead of growing less than 100 bushels per acre, should double their production. Wherever only 600 to 800 pounds of tobacco are got from an acre, three-fourths of a ton is the prospect.

Fruits, berries, and vegetables have a future too large to estimate. The cannery and the railway fast freight and refrigerator car have overcome obstacles of latitude, of longitude, and of season, and there is every indication that the farmer can supply any possible demand for these foods at home or abroad.

ANIMAL PRODUCTS.

Farmers will learn how to feed more prolific breeds and strains of swine than the ones which they are now chiefly raising, and thus will pork and its products be increased per individual of the permanent stock of hogs. One-fourth of the dairy cows of the country do not pay for their feed, and more than half of them do not return any profit; in proportion as the dairyman weighs the milk of each cow and applies the Babcock test will he increase the supply of milk, butter, and cheese. It is merely a matter of education.

Poultry is one of the steady and helpful sources of farm income. Movements are already on foot which may be expected to increase the egg production per hen by at least a dozen per year within a generation; and there are poultrymen who are not enthusiasts who foretell double that increase. If the hens of this year had each laid a dozen eggs more than they did, the increased value of this product would have been possibly $50,000,000.

A MATTER OF EDUCATION.

The farmer will not fail the nation if the nation does not fail the farmer. He will need education to know the powers of the soil which are now hidden from him. The prospective yearly expenditure of $10,000,000 for educational and research work by Nation and States, with such increases as may come from time to time, must have enormous effects. There may be agricultural schools for the small children, and agricultural high schools for the larger ones, and their education will be continued in the colleges.

The work of the Department of Agriculture has already had results which are valued at hundreds of millions of dollars annually, and yet

the Department feels that it has barely crost the threshold of its mission of discovery and education. Cooperating to the same ends are 60 experiment stations in 51 States and Territories, the 63 agricultural colleges, thousands of farmers' institute meetings yearly, many excellent agricultural periodical publications and new instructive books. Then there is a new line of work which is so productive of results that it is constantly extending, and that is the demonstration farm, the encouragement of individual farmers to change their agriculture so as to multiply their yields and their profits, and thus afford object lessons to other farmers.

Thus it appears that forces are now at work which will very considerably increase the production of the farms within a generation, and which promise to continue the increase indefinitely. He who would write the last chapter of the progress of the agriculture of this country must await the procession of the centuries.

OPENING OF A NEW ERA.

The farmer is financially in a position now to do what he could not have done previous to the recent years of his prosperity.

ADVANCE OF FARMERS' WELFARE.

National welfare has been promoted by few revolutions in agricultural economics to the extent that it has been and will be promoted by 10-cent cotton. The greater part of the cotton planters are out of their former bondage to future maintenance, and they are paying no enormous rates of interest for advancements—rates which were estimated fifteen years ago to average 40 per cent a year.

In the Middle West the prosperity of the farmers during the last half dozen years and over has advanced in such mass and with such speed that no parallel can be found in the economic history of agriculture. One of the great changes that have come over this region is the conversion of a million agricultural debtors, paying high rates of interest and finding great difficulty in procuring the wherewithal out of prices much too low, into financially independent farmers, debt-free, and begging the banks to receive their savings at as small a rate of interest as 2 per cent.

POWER OF THE FARMERS' NEW CAPITAL.

Farmers are using their new capital to abolish the waste places of the land. The river is leveed and alluvial bottoms subject to overflow become worth hundreds of dollars per acre for vegetables; a marsh is drained by ditches and tiles and celery makes it the most valuable land in the county; semiarid land is constantly cultivated so as to make a mulch of finely pulverized earth on the surface, and the crops that it will grow make the farmer prosperous; durum wheat or alfalfa is introduced and again the semiarid wastes are made to do the will of the cultivator; leguminous plants give humus and nitrogen to the sandy waste, to the use and profit of the farmer; the unused rocky, stony field or mountain side, offensive both to the economic and to the esthetic eye, blossoms with the apple, the peach, the pear, and the plum, and adds to the evidences that every square foot of the land may be made productive unless it is arid; and even then irrigation works, as far as water is available, swell the evidence. Along all of these lines of production farmers are using their newly acquired capital and are progressing as never before in their prosperity.

Formerly there was an abundance of farm labor and a dearth of farming capital; now these conditions are reversed and labor is scarce and capital abundant. Notwithstanding the farmers' inability to do some things for want of labor, the new situation is a great improvement upon the old one. The farmer can now employ every labor-saving device and thus reduce both the labor and the cost of production; he can raise his land to a higher state of fertility than can be made by chemical fertilizers alone, because he can advance the needed capital for permanent soil improvement and is in a position to await results; he can produce things that require years for the first crop, as in the case of fruits; he can provide such capital as is needed to distribute his products and thus cooperation is open to him to a greater extent than ever before; he can secure a better education for his children to the end, among other things, that they may do better with the old farm than he did.

PROMISING OUTLOOK.

The farmer's standard of living is rising higher and higher. The common things of his farm go to the city to become luxuries. He is becoming a traveler; and he has his telephone and his daily mail and newspaper. His life is healthful to body and sane to mind, and the noise and fever of the city have not become the craving of his nerves, nor his ideal of the everyday pleasures of life. A new dignity has come to agriculture, along with its economic strength; and the farmer has a new horizon far back of that of his prairie and his mountains, which is more promising than the sky-line of the city.

For the abundance that the Creator has sustained the farmer in supplying, for the stability of the national agriculture, and for the comforting prospect of a potent future, there are many evidences that the people are ready to join in a day of reverent and joyous Thanksgiving.

It is no little gratification to the head of this Department in presenting the foregoing picture of the farmer's place in the economy of the country and picturing the possibilities of his future to realize that this Department and its work have had an important share in the development which has culminated in the farmer's present prosperity, and that they are bound, if intelligently and generously administered, to play an important part in the future of American agriculture. With this thought in mind I will proceed to present for your consideration a review of the various channels thru which the Department performs its important work and to place on record what has been done thru them during the past year.

WEATHER BUREAU.

FORECASTS AND WARNINGS.

The Weather Bureau has issued warnings of dangerous gales on the Great Lakes and along the seacoasts, and has kept the great commercial and agricultural interests of the country as fully advised as possible of the coming of adverse weather conditions.

EXTENSION OF THE FIELD OF OBSERVATION.

Its field of observation is being gradually extended in the hope that a view of the atmospheric conditions which prevail over the great oceanic and continental areas will prove of especial value in making

forecasts for this country. The two points from which advices of atmospheric changes are most desired at present are Siberia and the region in and about Bering Sea. It is hoped to obtain reports from Siberia thru the courtesy of the Russian Meteorological Service. The laying of a cable by the United States Signal Service, connecting Alaska with this country, makes it feasible to secure much-desired weather reports from that part of the globe.

EXTENSION OF STORM-WARNING SERVICE TO VESSELS AT SEA.

During the year a plan has been perfected whereby vessels at sea equipped with wireless telegraphic apparatus may receive warnings of severe storms if within communicating distance of shore stations, or of other vessels which have received a warning.

OBSERVATORY BUILDINGS.

Five observatory buildings have been completed during the year, and one (the physical laboratory at Mount Weather, Va.) has been partially completed. The number of buildings of all classes now owned and occupied by the Weather Bureau is 41.

DISTRIBUTION OF FORECASTS THRU TELEPHONE EXCHANGES.

The number of telephone subscribers receiving the daily forecasts on June 30, 1905, was 464,738. This number was augmented during the year by over half a million, so that at the close of this fiscal year more than a million telephone subscribers were receiving the daily forecasts.

INVESTIGATION OF FROST CONDITIONS IN CRANBERRY DISTRICTS.

A special investigation has been carried on during a part of the year, having as its object the establishment of a scientific basis for accurate frost predictions in the cranberry regions of the country, especially in Wisconsin. The conditions of both soil and air which shortly precede and accompany frost have been studied closely, and much valuable data have been secured.

INCREASE IN THE WEATHER SERVICE.

The utilities of the Weather Bureau are such that there is a constant and growing demand for an extension of the service so as to provide for telegraphing and publishing more meteorological data and establishing additional Weather Bureau stations. However, special effort is made to meet these demands with the existing appropriation, and no request that involves asking Congress for additional funds is honored except after a careful and thoro investigation of the necessities of the case.

There is already an extensive output of meteorological information that comes from the 183 full meteorological stations maintained by the Bureau and from several hundred stations reporting only temperature and rainfall. The daily output finds its way to the public mainly thru the columns of the newspapers and in the maps and bulletins issued at

Washington and outlying stations. Outside of Washington there are 105 stations which issue an aggregate of 25,000 weather maps daily, making a yearly issue of over 8,000,000 copies. The number of monthly climatological reports printed at 40 different section centers is 30,944, being an average of about 700 copies per month from each center; these contain the daily climatological features of various climatic districts. There is a constant demand from agricultural, commercial, and shipping interests for an additional amount of such data.

MOUNT WEATHER RESEARCH OBSERVATORY.

Progress has been made in the establishment of the Mount Weather Research Observatory. A station of the first order has been maintained thruout the year for taking and telegraphing reports that are useful in making forecasts.

In the preparation for kite and balloon work, a number of important instruments have been installed and made ready for systematic work. Observations of the upper air are now being regularly taken in concert with similar aerial research institutions in foreign countries.

The interior finishings of the magnetic observatory buildings, the erection of the piers, and the installation of the magnetic instruments were completed during the year, and automatic and other records are now being continuously made.

RECORDS OF EARTHQUAKES.

The attention drawn to scientific observation of earthquakes by the calamity that befell San Francisco on April 18, last, has prompted the Department to authorize the Weather Bureau to install an additional number of instruments at places of observation where the Department owns buildings and suitable ground. It is probable that during the coming year about 15 or 20 additional stations will be equipped with seismographs, so that the progress across our continent of earth vibrations can be more accurately measured and the data submitted for scientific discussion. These additional observations can be secured with only the expense involved in the purchase of instruments and their installation.

BUREAU OF ANIMAL INDUSTRY.

THE MEAT INSPECTION.

Meat inspection has been for several months a very live topic before the public. During the year the Federal meat inspection was conducted by the Bureau of Animal Industry at 163 establishments in 58 cities, and 42,901,284 animals were inspected at the time of slaughter, nearly all of them having also been previously inspected in stock yards. This represents the greatest amount of work done in any one year since the inspection was inaugurated in 1891. Of the animals inspected, 158,953 carcasses and 126,159 parts of carcasses were condemned for disease or other cause. The total cost of the meat inspection, including the microscopic inspection of pork for export to certain countries, was $852,561.70.

The importance of more thoro meat inspection and sanitation has been forcibly shown by the recent agitation and investigations relating to some of the packing-house methods. The new law which was designed to correct certain evils was past by Congress June 30, 1906,

and hence the work of the fiscal year under review was performed under former laws, which were, in many respects, defective and unsatisfactory. The act of March 3, 1891, as amended March 2, 1895, provided for the inspection of all live cattle intended for export or whose carcasses or products were intended for export; also for the mandatory ante-mortem inspection of cattle, sheep, and hogs, and the additional permissive post-mortem inspection of their carcasses for interstate trade. It has never been possible, however, to apply the inspection to all the establishments coming within the law, since the appropriations have been insufficient for that purpose. Many establishments which desired inspection have had to be refused because of lack of funds to extend the service. Many that should have been compelled to have inspection were able to avoid it, as the former laws compelled inspection only in the case of export beef.

The law gave the Department no authority whatever to control the sanitation of abattoirs and packing houses, or to prevent adulteration or the use of chemicals and preservatives; nor was any authority given for following up meats which had once been inspected and past immediately after slaughter, or for condemning any such meat which might afterwards have become unwholesome or unclean before or during the process of canning or packing or before being placed on the market. The inspection was therefore practically limited to the ante-mortem inspection of animals and the inspection of the carcasses immediately after slaughter. The meat found free from disease and otherwise wholesome at the time of this post-mortem inspection was properly marked, and that found diseased or unwholesome was destroyed. This inspection was efficient so far as it went, and it went as far as the law and the limited appropriations permitted. In its efforts to maintain an efficient inspection the Department sometimes even assumed authority not conferred by law, notably by requiring the destruction of condemned carcasses. In all the recent agitation the wholesomeness of the inspected fresh meat has not been seriously questioned. The disclosures of unsatisfactory conditions have related almost wholly to matters over which the Department had no legal control, such as the preparation of sausages, canned and cured meats, etc., the use of preservatives, and the insanitary condition and methods of the packing houses.

Realizing the shortcomings of the old law, the Department has several times in the past recommended the enactment of new legislation and the increase of appropriations for the extension and improvement of the service. Bills designed to remedy some of the defects were at different times introduced in Congress but failed to pass.

Even before the appearance of recent publications criticizing the insanitary conditions at the Chicago stock yards and packing houses, and reflecting upon the Federal meat-inspection service, steps had been taken to investigate these matters. A committee consisting of Dr. John R. Mohler, chief of the Pathological Division of the Bureau of Animal Industry, Dr. Rice P. Steddom, chief of the Inspection Division of that Bureau, and Mr. George P. McCabe, Solicitor of the Department, was sent to Chicago and made a thoro investigation. They made an exhaustive report, which was promptly transmitted to the President and was afterwards by him laid before Congress. An independent investigation was also made under the President's direc-

tion by Messrs. Charles P. Neill and James B. Reynolds. Prompt and vigorous measures were taken to remedy the conditions disclosed by the reports of these committees, but it was realized that the Department could do very little under existing law and that the real remedy lay in new legislation backed by public sentiment.

Such new legislation was provided by Congress in the so-called meat-inspection amendment to the agricultural appropriation act of June 30, 1906. This law provides for a more thoro and comprehensive inspection system and makes a permanent annual appropriation of $3,000,000 to pay the cost of the inspection. With the greater authority now vested in the Secretary of Agriculture and with the largely increased appropriation, the service will be greatly extended in scope and in the number of establishments and quantity of product covered. The inspection will be extended as rapidly as possible to establishments engaged in interstate or foreign commerce and which come within the law. It will be applied not only to the live animals before slaughter and their carcasses at the time of slaughter, as heretofore, but also to the meats and meat food products in all the subsequent stages and processes of preparation, curing, canning, etc. Sanitary equipment, conditions, and methods will be required, the use of harmful chemicals and preservatives and of false and misleading labels will be prevented, and the transportation of meat in interstate and foreign commerce will be supervised and regulated. It is probable that it will be necessary to request Congress to appropriate an even larger sum to provide inspection for all establishments embraced within the law.

American live stock has long been considered the healthiest in the world. With our enlarged and improved inspection system, the stamp of the Government will be more than ever a mark of wholesomeness.

We must not imagine, however, that since the packing houses have been cleaned up and the inspection improved all the meat found in our local markets may be considered clean and wholesome. It must be borne in mind that the Federal jurisdiction is limited to interstate and foreign commerce, and that this inspection can legally be applied only to establishments doing an interstate or foreign business. To be sure, the Department insists on inspecting the entire output of each establishment at which its inspection is maintained, even tho part of the product is to be consumed within the State; but the Federal inspection does not and can not reach the establishments doing business exclusively within a State. The Department, under the new law, can and will enforce cleanliness and sanitation in the establishments doing an interstate and export business, but it is powerless to reach the local houses. The latter must be lookt after by the State and municipal authorities. Each State or community must protect itself against unwholesome meats originating within the State. In the absence of an efficient local inspection the consumer's only safety lies in seeing that meat bears the Government label.

INSPECTION OF EXPORT ANIMALS.

The export trade in live animals is fostered by the inspection conducted by the Bureau of Animal Industry. During the fiscal year more than 1,000,000 inspections were made before exportation, and over half a million animals were again inspected on arrival at British ports by Bureau inspectors stationed there. Seven hundred and forty-nine inspections of vessels carrying export animals were made before

clearance, and they were required to conform to certain regulations as to space, fittings, attendants, feed, water, ventilation, etc. The percentage of animals lost in transit was less than one-quarter of 1 per cent.

INSPECTION AND QUARANTINE OF IMPORTED ANIMALS.

Our domestic live stock is protected from the contagion of destructive diseases which exist in other parts of the world by a rigid system of inspection and quarantine of imported animals. In this service during the year 168,600 animals were inspected, and 1,898 of these were quarantined.

The quarantine stations on the Atlantic seaboard, with one exception, are in satisfactory condition. The station near Baltimore will soon have to be abandoned because of the dilapidated condition of the buildings and the building up of that locality. When a suitable location is secured an appropriation by Congress for the equipment of the new station will be necessary.

CONTROL OF CONTAGIOUS DISEASES.

The work for the control and eradication of contagious diseases of live stock in our own country has been attended with encouraging results. Sheep scab and cattle mange, which a few years ago had spread over the greater part of the Western States, are gradually yielding to our efforts. It is believed that their complete eradication will be only a matter of a few years. During the year sheep scab has been greatly diminished in Arizona and Idaho, and practically stamped out in Utah and Wyoming. Even more rapid progress has been made with cattle mange. Washington and Oregon, and large portions of Kansas, Colorado, Wyoming, Texas, New Mexico, and Oklahoma, have been freed from this disease and released from quarantine, and it is expected that the same will soon be true of extensive areas in North Dakota and South Dakota and other portions of Wyoming and Texas.

Maladie du coït, or dourine, an insidious venereal disease of horses, which existed in portions of South Dakota, Nebraska, and Iowa, is now believed to have been eradicated, after several years of vigilant work. Out of 965 inspections during the year no positive cases and but 3 suspicious cases were found.

ERADICATION OF THE TEXAS-FEVER TICK.

Under the provisions of the act of Congress approved June 30, 1906, appropriating $82,500 to enable the Secretary of Agriculture to undertake experimental work in cooperation with State authorities in eradicating the ticks transmitting Southern cattle fever, the Department has for some months past been assisting the States and Territories from California to Virginia along these lines. Anticipating the action of Congress an investigation was made respecting the laws of the various States, and thru the various attorneys-general inquiry was made relative to the existence of State laws under which the Government could undertake the work of tick eradication. It was found that, while some State laws afford ample provisions, other States either have no law bearing on the subject, or the statutes are inadequate. The table following shows the particular points covered by the investigation and the general trend of the information received.

Provisions of State laws relating to quarantine, disinfection, etc.

State.	Questions and answers.			
	Are local officers authorized and empowered to enter premises to inspect live stock and enforce quarantine, including counties, districts, farms, and ranches, and to control the movement of live stock?	Are such officers empowered to enforce such disinfection of animals and premises as may be necessary?	Are State officials authorized to issue rules and regulations establishing and maintaining quarantine lines?	May the State confer authority upon Federal representatives to act as officials of the State in such matters?
Alabama	No live-stock quarantine or sanitary law.			
Arkansas	Peace officers may enforce quarantine lines fixt by law and by the United States.	No	No	
California	Yes	Impliedly	Yes	As county officials only.
Florida	No live-stock quarantine or sanitary law.			
Georgia	Yes; impliedly so	Yes	Yes	Not prevented.
Indian Territory	No law to cover these matters.			
Kentucky	Yes	Yes	Yes	Yes.
Louisiana	Yes; impliedly so	Yes	Yes	No.
Mississippi	No live-stock quarantine or sanitary law.			
Missouri	No	No	No	No.
North Carolina	Yes	No	Yes	Yes.
Oklahoma	Yes	Yes	Yes	Yes.
South Carolina	No law to cover these matters.			
Tennessee	Yes	Yes	Yes	Not prevented.
Texas	Yes	Yes	Yes	No.
Virginia	Yes	Yes	Yes	Yes.

The matter was early taken up with the proper officials in the States and Territories interested and arrangements were made for the Department to cooperate with them to the extent that their respective laws would permit. Under these arrangements the work has been done in close cooperation with the local authorities, who were permitted to designate the counties or localities to be covered and to recommend for appointment as agents of the Department men acquainted with the local conditions in the respective localities.

The territory in which it was desired to operate was divided into five sections, as follows:

1. California.
2. Texas, Oklahoma, Missouri, Arkansas, and Louisiana.
3. Kentucky, Tennessee, Alabama, and Mississippi.
4. Georgia and South Carolina.
5. Virginia and North Carolina.

The work was organized as soon as possible after the passage of the law, but it was late in July before it could be begun at all, and even later before it could be taken up in some sections.

As the conditions in the different sections were widely divergent, the plans of procedure and methods employed necessarily varied greatly. In some States meetings were held at which the subject of tick eradication was discust with farmers, stockmen, and other interested citizens. These meetings were intended to be largely educational, but they gave an opportunity to petition State authorities for relief and to express preference for local inspectors, thus developing an enthusiasm and interest that can only come from a close personal identification with an enterprise of this sort. In some places it was necessary to employ inspectors who could live in the saddle and wield a lasso like a cowboy. These men worked in groups of about a dozen, each group having a cook and a camping outfit. They covered their territory systematically, roping and examining cattle wherever found,

and informing the owners of infested animals of the most practical method of getting rid of the ticks. It was found advisable to buy a carload of crude petroleum (in barrels) for use in the treatment of infested animals. This oil was distributed and used under the immediate supervision of inspectors of the Department in the southeastern States, and was doubtless the means of doing what could have been done in no other way, as the crude oil is difficult to obtain in small quantities and at points far distant from its production.

The following table shows by States the number of herds inspected, the number of cattle inspected, the number found free of ticks, and the number found to be infested—the grand total of inspections being 29,315 herds containing 522,529 cattle:

Results of inspection work to October 31, 1906.

State.	Inspections.				Number of counties.
	Herds.	Cattle.			
		Free.	Infected.	Total.	
Alabama	780	4	5,550	5,554	2
Arkansas	1,567	6,671	2,332	9,003	2
California	1,015	67,517	58,889	126,406	11
Georgia	4,474	10,053	6,365	16,418	7
Kentucky[a]	4,077	13,653	7,332	20,985	4
Missouri	126	3,000	1,430	4,430	3
North Carolina					
Oklahoma	10,589	57,860	16,972	114,832	5
Tennessee[b]	6,317	23,204	15,840	39,044	17
Texas	410	86,682	99,175	185,857	17
Virginia					
Total	29,315	338,644	213,885	522,529	68

[a] In addition, in Kentucky 1,396 herds and 6,904 cattle were reinspected.
[b] In addition, in Tennessee 822 herds and 4,174 cattle were reinspected.

The work is still progressing in some States, but will be practically discontinued about December 1 on account of the lack of funds. The outlook for next season's operations in the different infested sections is very encouraging, and the work should be resumed in the early spring.

In considering the work done and the results attained thus far it should be borne in mind that the season was well advanced before the law was past, and that, altho some steps were taken in anticipation of its passage, yet the actual plans and organization for the work were late in formation. It should also be remembered that the amount appropriated was only intended to be used to inaugurate the work, and yet, as set forth above, employees of the Department have inspected 29,315 herds, containing 522,529 cattle, and have, in connection with local authorities, so attended to their disinfection and to the supervision thereof that forty whole counties and parts of eleven other counties, with an aggregate area of almost 50,000 square miles, will probably be released from quarantine before the end of this fiscal year. This is an area larger than that of the entire State of Virginia. Plans are laid and specific work is outlined for resumption in the early spring. The State officers, cattle owners, and others affected are intensely interested; educational work will be carried on, and there is every reason to believe that, with proper funds at the disposal of the Department next season, large inroads may be made into the territory now quarantined, and hundreds of thousands of cattle be given an unrestricted market, thus giving direct results to an immense number

of people. This will stimulate interest in those States in which active interest is now lacking and will doubtless result in a more general movement against the cattle tick.

If the Congress at its next session will appropriate $250,000 for extending these operations and will continue to adequately sustain them, and the States interested will do their part in the way of enacting favorable laws and appropriating money to be used in this cooperative work, it is only a question of time when the southern cattle tick in this country will be a thing of the past.

SCIENTIFIC INVESTIGATION OF DISEASES.

The scientific investigations of contagious diseases by the Bureau of Animal Industry have yielded results of especial importance with regard to tuberculosis and hog cholera during the past year.

TUBERCULOSIS.

The increasing and alarming frequency of tuberculosis in hogs, as observed in the meat-inspection service during recent years, led to experiments to determine the most probable source of infection of these animals. The practical conclusions of these investigations are that the most frequent causes of tuberculosis in hogs are to be found in the common practises of allowing these animals to follow cattle in the feed lot and of feeding them on skimmed milk or separator refuse. The feces of tuberculous cattle have been found to be heavily charged with tubercle bacilli. The experiments indicate that animals with tuberculous lungs, while they do not expectorate after coughing up tuberculous material, nevertheless scatter the bacilli freely by swallowing them, having them pass thru their intestines, and discharging them with their feces. Hogs readily contract tuberculosis from eating the excrement of tuberculous cattle. For milk to be infected with tubercle bacilli it is not necessary that the udder should be diseased; infected feces are believed to be a common cause of contamination of milk drawn in the environment of tuberculous cows. Thus it seems that a single diseased cow may be the means of infecting the milk of an entire herd.

Other experiments showed that the location of lesions in the bodies of animals affected with tuberculosis is no guide to the mode or channel of infection. For instance, lesions in the lungs have usually heretofore been regarded as indicating that the infection was acquired by inhalation. The incorrectness of this view was shown by producing lung disease by inoculating hogs in the tip of the tail and by feeding them with tuberculous material.

These results emphasize anew the great importance of every farmer keeping his herd free from tuberculosis.

Experiments in the application of the tuberculin test to hogs showed that when proper precautions are taken tuberculin is about as accurate in detecting tuberculosis in hogs as in the case of cattle. The test was found reliable in 97 per cent of the infected experimental animals.

HOG CHOLERA.

Hog cholera has long been a cause of heavy loss to the farmers, and for years scientists in the Department and in various parts of the world have been working on the problem of the cause and prevention

of this disease. Recent work of the Bureau of Animal Industry has demonstrated that the contagion consists of a virus which exists in the blood and other fluids of diseased animals, but which can pass thru the finest filter, is invisible under the microscope, and therefore can not be isolated or discerned by any of the usual methods. This important discovery, which has since been confirmed by eminent scientific authorities in England and on the Continent of Europe, affords an explanation of the failure of past efforts to produce a satisfactory vaccine.

The real cause of the disease having at last been determined, the Bureau has during the past season conducted experiments with a view to producing a vaccine or serum which will prevent or cure the disease. Successful results have already been obtained in an experimental way, and efforts are now being made to adapt the method to practical and general use. The method has been patented by the Department in the name of the scientist who evolved it, Dr. Marion Dorset, the patent having been taken out in such a manner as to insure to all the people in the United States the right to its use free of royalty.

PARASITES OF SHEEP.

The stomach worm or twisted wireworm of sheep, a parasite causing great damage to flocks in many parts of the United States, has been studied, and the principal facts in its life history, which have hitherto been unknown, have been worked out. The eggs of the parasite are scattered over the pastures in the droppings of infested sheep or cattle. The embryos, which in a certain stage are enveloped in a sheath which enables them to withstand freezing and dryness, climb up blades of grass. When infested grass is eaten by a sheep the embryos continue their development in that animal. Experiments now in progress indicate that with certain precautions it is entirely feasible to raise lambs free from this and some other troublesome parasites.

BLACKLEG VACCINE.

The Department has continued to supply blackleg vaccine free of charge to stock owners, and reports indicate that the prevalence of this disease is gradually being reduced. During the year 1,350,915 doses of this vaccine were prepared and distributed. The losses among animals treated with this vaccine during the previous year were less than one-half of 1 per cent.

PEDIGREE ASSOCIATIONS.

After consultation with officers of American pedigree record associations, the Department has radically changed the regulations regarding the importation of animals for breeding purposes. Hitherto certificates of approved domestic and foreign associations have been accepted with the requirement that they should show the ancestors for two generations. This requirement caused inconvenience and dissatisfaction to importers, but the Department felt that unless it could supervise more closely the books of record such a requirement was necessary to give a reasonable assurance of pure breeding. The new regulations simply require that animals imported for breeding purposes shall be registered in an approved American book of record in order to be entitled to free entry. Where a breed has no book of record in the United States the certificate of the Chief of the Bureau

of Animal Industry must be obtained. The records of the approved associations are closely supervised by the Department and must conform to prescribed conditions in order to remain on the approved list. This change should prove beneficial to the breeding industry. It will not only make officers more careful in the management of pedigree registers, but will practically compel the registration of imported pure-bred animals in American books.

HORSE-BREEDING INVESTIGATIONS.

Satisfactory progress is being made in the experiments in breeding heavy harness horses at the Colorado Experiment Station. The stud has been increased by the purchase of two Kentucky mares of desirable strains of breeding. It is considered advisable to increase further the number of experimental animals, and the Department should be prepared to purchase exceptionally good mares as opportunity offers. This line of experiments promises to be of the greatest value to American stockmen and should be carried out systematically and thoroly.

Experiments have been begun, in cooperation with the Vermont Experiment Station, in breeding Morgan horses with the object of preventing the loss of the Morgan blood, preserving the type, and increasing the size. Seven mares and two fillies were purchased in Vermont and two mares in Kentucky for these experiments.

FECUNDITY OF SOWS.

Some unexpected but instructive results were obtained by a study of the fecundity of Poland-China sows. It had been supposed that this breed of hogs was declining in fecundity, and the Department was urged to undertake experiments with a view to overcoming this tendency. An investigation into the pedigree records and a comparison of two periods of years, based upon nearly 55,000 litters, showed that the average number of pigs per litter was 7.04 during the years 1882–1886, and 7.52 during 1898–1902. There was thus an increase of 0.48 per litter instead of a decrease. These results led to a similar investigation of the Duroc-Jersey breed, and while the popular supposition that this breed is more prolific than the Poland-China was confirmed, it appeared that the average size of litters of Duroc-Jerseys had remained practically stationary for several years, the figures being 9.22 for 1893–1897 and 9.27 for 1898–1902. These investigations are being followed with studies of the inheritance of fecundity.

POULTRY BREEDING.

Investigations, with a view to developing a strain of chickens with increased egg-laying capacity, are being conducted in cooperation with the Maine Experiment Station. Several hens have been found to lay more than 200 eggs in one year, and the results seem to indicate that by selecting the best layers for breeding purposes and by proper feeding the average egg yield of a flock can be increased. The great benefit of such an increase is too obvious to require comment.

EXPERIMENTS IN ANIMAL NUTRITION.

A careful scientific study of the fundamental principles of animal nutrition by means of a respiration calorimeter has been in progress for several years at the Pennsylvania Experiment Station by cooperation between the Department and that station, and some important

and valuable results have been realized. Beginning with the food as a source of energy to the animal machine, the investigators follow this energy thru to its ultimate effect, determining how much escapes in the undigested residues of the food, how much is expended in the digestion and assimilation of the food, and what surplus remains to sustain the life of the animal or to enable it to produce meat, milk, or work.

The results thus far published include experiments with timothy hay, red clover hay, and corn meal, and they have shown that the so-called "fuel value" of feeding stuffs can not be taken as a measure of their nutritive value. The experiments have amply demonstrated that the real nutritive values of stock feeds are much less than their fuel values, the former ranging from 56 to 67 per cent of the latter in the particular feeds used. Experiments to study the effect of age and breed upon the percentage of food energy utilized have not been concluded.

FEEDING COTTON-SEED PRODUCTS TO HOGS.

The Bureau of Animal Industry has conducted experiments during the year to test the harmful properties of cotton seed and cotton-seed meal when fed to hogs. These substances proved fatal to the hogs, the time required to cause death being longer when a varied ration was fed than when only one kind of grain was fed in addition to the cotton-seed meal. The results obtained by experiment stations as to the fatal effects of cotton-seed products in combination with corn meal were confirmed, but it appears from the Department's experiments that bran and middlings, instead of neutralizing the injurious effect of the cotton seed, as had been concluded from experiment station work, gave results very little better than corn meal. The experiments with bran and middlings will be repeated and other tests made. Chemical and pathological studies are being made with a view to discovering the cause of the harmful effects of cotton seed when fed to hogs.

THE DAIRY INDUSTRY.

The work of the Dairy Division of the Bureau of Animal Industry has been considerably extended during the year. Results of a valuable and practical nature to the dairy industry have been obtained from investigations in the manufacture and storage of butter and cheese and the production and delivery of market milk; and a good beginning has been made in the work for the improvement and development of dairying in the South and the investigations and studies regarding the construction of dairy buildings and the organization and management of dairy enterprises.

BUTTER INVESTIGATIONS.

About 5,000 pounds of butter were made under different conditions and stored for eight months at different temperatures. The conclusion from this experiment is that the use of cream received at the creamery in a sweet condition, light salting of the butter, and low temperatures (10° F. below zero to 10° F. above zero) give much the best results for storage butter.

Two common troubles of butter makers—mold in butter tubs and the fishy flavor of butter—have been studied. The coating of tubs with paraffin has been found to be an effective method of preventing mold. Investigations regarding the fishy flavor have not progressed far enough to determine the cause of this trouble and are being continued.

A system of market inspection of butter at New York and Chicago has been started with a view to assisting creameries to improve the quality of their product. When butter arriving at one of these markets is found deficient in quality a statement of its condition is sent to the butter maker, to the dealer who purchases the butter, and to the dairy and food commissioner of the State in which the butter was produced.

CHEESE INVESTIGATIONS.

Further work was done during the year in the manufacture and storage of cheese. A quantity of American Cheddar style cheese was made, cured, and stored under varying conditions, and the details of the experiments, with a review of previous work on the subject, were published. The cheese that scored highest was that placed in storage at 32° F. directly from the press, while that scoring lowest was cured entirely in the factory curing-room at about 65° F. Cold curing appears to derive its value chiefly from its effect on what otherwise might be poor cheese. The popular taste is growing decidedly toward mild cheese, and to meet this demand it seems desirable to have cheese ripened, so far as it is ripened at all, at low temperatures.

The experiments in the manufacture of soft cheese of leading European varieties have been continued thruout the year in cooperation with the Storrs (Conn.) Experiment Station. During the winter a scientist connected with this work spent two months in Europe studying the manufacture of cheese, and these studies have resulted in marked progress in our investigations regarding Camembert and Roquefort cheese. While there are some problems yet to be investigated, the knowledge so far gained of the fungi, methods, and conditions necessary in the production of these kinds of cheese indicates that it is entirely practicable to manufacture in this country soft cheeses of these types fully equal to the best European product.

THE PRODUCTION AND HANDLING OF MILK.

Probably no article of food is more generally consumed than milk, and in striving for pure foods a wholesome milk supply must be considered of prime importance. During the year the Dairy Division has investigated the milk supplies of various cities, and has begun studies of the organization and working of milk sanitary commissions and other bodies whose object is to improve the quality of market milk.

The competitive exhibit of milk and cream at the National Dairy Show in Chicago in February was in charge of the Dairy Division and gave an object lesson of great educational value. It was demonstrated that milk and cream produced under sanitary conditions could be shipped long distances and kept sweet for several weeks without any other means of preservation than cleanliness and low temperatures.

DAIRY IMPROVEMENT IN THE SOUTH.

A careful survey of dairy conditions in the South has been made as the first step in the work of improving these conditions and promoting the dairy interests of that section. This preliminary work has shown that while in some cases southern dairy herds are yielding as good results as are ordinarily expected in any part of the country, there is great need thruout the South for education in improved methods of dairy breeding and feeding and milk production. Many of the south-

ern people show a desire to learn more of dairying so as to get away from the one-crop system. One serious handicap is the inferior class of cattle found there, probably due largely to the presence of the cattle tick.

OTHER DAIRY WORK.

To meet the demand for information and assistance as to the construction of dairy buildings, some studies and experiments have been and are being made. A circular giving plans for an improved dairy barn was published, and many plans for dairy buildings of various kinds have been worked out and sent to farmers thruout the country. Some experiments have been made in building silos of three types of construction.

Investigations into the organization, equipment, and management of creameries and cheese factories have been undertaken to enable the Department to give advice and assistance on these subjects.

RENOVATED BUTTER.

In the administration of the portion of the law of May 9, 1902, which relates to renovated butter, the Department has continued its supervision of the manufacture and sale of this article. The factories and ingredients are inspected to insure sanitary conditions and wholesomeness, and the product is inspected in the markets with a view to detecting and preventing violations of the law and regulations as to proper labeling. The factories are in better sanitary condition than in past years, and as a rule the manufacturers show a disposition to comply with the law and regulations. Evidence of the illegal sale of renovated butter by dealers in several cities has been collected, however, and some prosecutions have been instituted. The regulations of the Department have been sustained in two court decisions.

BUREAU OF PLANT INDUSTRY.

A leading feature of the work of the Bureau of Plant Industry during the past year has been the cooperative demonstration work with farmers, fruit growers, and others. It has been my established policy to have our own officers carefully scrutinize all operations, including those which involve the conducting of business as well as those in which both field and scientific investigations are concerned.

INTRODUCING NEW CROPS AND NEW INDUSTRIES.

The search by agricultural explorers in foreign lands for new crops has been continued. A trained man has spent the last year in the cultivated fields and wild mountains of north China and Manchuria searching for new plants and seeds worthy to be transplanted to this country and for wild forms of our cultivated fruits and vegetables which may have characters of hardiness or unusual vigor that will make them useful for the plant breeders of the United States. Shipments of scions and of seeds representing hundreds of interesting things have been sent in and are now growing in the trial gardens of the Department. Among the things secured are new hardy Pekin persimmon varieties, interesting varieties of the English walnut, the Chinese pistache, wild and cultivated apricots, the wild peach from its supposed original home, hardy apples and edible-fruited hawthorns, millets and field beans, a lawn sedge that is promising, and a very remarkable lot of Chinese grape varieties, not to mention a most

unusually interesting collection of ornamental trees and shrubs suited to the climate of the Eastern and Middle States.

NEW ALFALFAS AND OTHER CROPS.—One of the most important achievements of the Bureau's exploration work is the recent discovery by Prof. N. E. Hansen, of the South Dakota Agricultural Experiment Station, who is now abroad in the interest of the Department, of the existence of a Siberian alfalfa, an excellent forage plant with yellow instead of the usual blue flowers. This plant is native on the dry steppes of Siberia, where the mercury sometimes freezes without snow, thus proving the ability of the plant to withstand with no protection a temperature of about 40 degrees below zero. The existence of this alfalfa has been suspected for many years, and its final discovery, it is believed, may mark an epoch in the agriculture of the northwestern prairie regions of the United States, where the rainfall is slight and the winters are exceedingly cold. Professor Hansen is making a very careful study of this plant, with a view to its cultivation in this country. A quantity of the seed of this valuable crop has been secured, which will be given a thoro trial by the Department at an early date. It will supplement durum wheat in a rotative system and avoid the necessity of summer fallowing.

The most distinct of any of the alfalfas is the newly introduced Arabian, characterized by its large leaflets, hairiness, and vigorous growth. Its quick recovery after cutting renders an extra cutting possible in long seasons. It is proving of special value in the irrigated sections of California and the Southwest, tho its lack of hardiness makes it unsuited to the colder parts of the country. Attempts are under way to establish strains resistant to cold and drought.

A species of vetch called the Tangier pea has proved superior to all others in California in its luxuriance of growth, having yielded as high as 9 tons of green feed per acre. On account of this great amount of herbage it chokes out weeds very effectually. As a green manure crop it promises in California to supersede all others. Its value as forage remains to be ascertained. A large quantity of seed is being grown so as to introduce it extensively next season.

A most luxuriant subtropical grass, called the Para grass, has proved well adapted to the Gulf coast region, Arizona, and California. Where sufficient moisture is provided this grass will yield about 8 tons of hay per acre. It is coarse in quality, but very nutritious. The seed is very poor in quality, but the grass can readily be grown from cuttings, one plant covering 100 square feet or more in a season. It is planned to distribute the cuttings extensively in the spring of 1907.

ENCOURAGING THE MATTING INDUSTRY.—The United States imports every year larger and larger quantities of hand-made floor coverings made from several species of aquatic rushes and sedges that grow pretty generally over the world. In 1906 more than 50,000,000 yards were imported, and more than $4,000,000 paid for them, notwithstanding the fact that looms have been invented that can weave the rushes into useful floor mats. These looms, the result of American ingenuity, when tended by single operators, can turn out more than 30 yards of matting a day—a strong contrast to the hand looms in use in foreign countries from which we draw our supplies of matting. The common rushes of our neglected swamp lands and tidal regions can be made into matting, but these lack the delicate, slender character of the cultivated forms in use in the Orient, India, and Africa. Our explorers have been gathering living plants of the best foreign

varieties, as well as selecting the most promising native types for trial plantings in the abandoned rice plantations of the Carolinas and for the delta regions of the Mississippi and Rio Grande, where cheap lands, which are not now growing profitable crops, are awaiting for a new plant culture.

A NEW SUBTROPICAL FRUIT.—The Florida fruit growers have had their enthusiasm aroused this year by the ripening of several of the delicious, fiberless East Indian mangoes which the Department has introduced. The collection is one of the largest in the world and Florida growers are waiting to see the behavior of the different sorts now under trial before planting large areas in this fruit, without doubt one of the great fruits of the world.

SUCCESSFUL DATE CULTURE.—The date palms introduced by the Department into southern California and Arizona have borne hundreds of pounds of delicious fruit this year. Even the famous Deglet Noor from the Sahara has ripened perfectly in the Salton Basin, proving that this unique desert culture has past from the stage of a pure experiment into that of a new industry.

THE PISTACHE NUT.—The investigation of the pistache, a promising dry-land nut crop, has resulted in a distinct widening of the possibilities of its culture thru the introduction from Turkestan of hardy forms. Three wild species suitable for stocks have been introduced from the driest deserts of the Old World, and a very hardy stock has also been secured in northern China.

INVESTIGATIONS BY THE PATHOLOGISTS.

The year has been an unusual one in the field of plant pathology. There have been serious outbreaks of disease and the staff of men engaged in this work has been kept very busy.

PEAR BLIGHT.—The Department has worked out by careful bacteriological investigation methods of controlling this serious menace to the pear and apple industry. The disastrous attacks of the old eastern pear blight upon the magnificent pear orchards of California have brought into prominence the importance of this work. During the past six years the Department has been engaged in demonstrating on a small scale in certain isolated orchards the practicability of controlling the disease, mainly by the eradication of the blighted portions of the tree and the antiseptic treatment of the wounds. Strenuous efforts are being made by the Department, in cooperation with the State experiment station and the State and county horticultural commissioners of California, to assist in applying these methods in saving the California orchards. The pear orchards of California represent a valuation of about $15,000,000, producing an average annual income to the fruit growers of $1,500,000. One-third of this, at least, has already been destroyed, but we hope to help the growers to save the remainder. Pear blight is destroying the pear industry in several other western States, and urgent requests have been made for assistance, which the Department expects to grant as far as it is able.

LITTLE PEACH AND PEACH YELLOWS.—The little peach disease has now been kept under control for three years on the test area in Michigan, and it is believed that the efficacy of the method has been fully demonstrated there. Work has therefore been transferred to a similar demonstration, in cooperation with the Cornell Experiment Station, in a test area in Niagara County, N. Y. This is confidently

expected to show the possibility of greatly reducing the ravages of the little peach disease and also of the peach yellows.

Peach yellows has been unusually destructive in West Virginia and Maryland during the past season. Department experts have been studying the disease in cooperation with the West Virginia State Experiment Station and urging the application of eradication methods. In one district, at least, in West Virginia, fully 90 per cent of the peach trees have been destroyed by the yellows during the past three years, and mainly during the present season.

APPLE BITTER ROT IN THE OZARK MOUNTAIN REGION.—Last season's successful spraying experiments in Virginia demonstrated for the first time the possibility of controlling bitter rot of the apple on the Yellow Newtown variety and indicated the exact dates of treatment. This work has now been transferred to the Ozark districts of Missouri and Arkansas. Here it has been tested on a much larger scale and on different varieties of apples. The results fully corroborate last year's conclusions and have demonstrated the entire feasibility of practically complete control of this serious orchard disease. Some minor rots and defects of the apple have also been more completely brought under control as a result of this treatment.

GUMMING FUNGUS OR SHOT-HOLE FUNGUS OF THE PEACH.—The gumming fungus or shot-hole fungus has been increasing in California at an alarming rate during the last five or six years and has resulted in very severe losses to the peach growers of that State. It threatens the destruction of the peach industry of the Sacramento and San Joaquin valleys. A treatment was suggested, after proper study by Department officials, which has been wholly successful.

WILT-RESISTANT MELONS.—Wilt has nearly destroyed the watermelon industry in many sections of the South. All known varieties of melons have been tested, but none resistant to the disease was found. It was found, however, that the citron is resistant, and the Department undertook by hybridization to breed this quality into the melon. The result has been successful, and there has been secured and fixt a variety of melon very resistant to wilt—a heavy yielder, of excellent quality, and well adapted to shipping. Next season it will be propagated for distribution.

WILT-RESISTANT COTTON.—The wilt-resistant selections of Sea Island cottons are now regularly used in the infected soils in the Sea Island districts of South Carolina. The loss from this disease has thus been practically eliminated in the principal region in which this special cotton is grown. The disease is still causing much loss in the interior districts, where this variety of cotton is grown, owing to the fact that many of the growers do not appreciate the value of resistant seed. Demonstration tests, however, are rapidly convincing them. Excellent wilt-resistant selections of Upland varieties have also been secured. Seed will be distributed this year to cooperators and propagated next year for more general distribution.

DISEASE-RESISTANT POTATOES.—For several years this Department has been testing various American and European varieties of potatoes, especially for disease resistance, and has now secured several good varieties resistant to both the early and late blight, as well as to tipburn and flea beetles. The work is carried on principally in cooperation with the Vermont Experiment Station, tho several other States are also cooperating.

PROGRESS IN CEREAL WORK.

EXTENSION OF THE WINTER WHEAT AREA.—About four years ago the Department began a systematic distribution of the Kharkof wheat, and extensive trials of this variety in cooperation with the State experiment stations. It is the hardiest winter wheat yet grown in this country, and is now thoroly established. By its use the area in which winter wheat can be successfully cultivated has been much extended to the northward and westward, particularly in Nebraska and Iowa, while a considerable amount is now grown in South Dakota and southern Minnesota. It will be conservative to state that wherever this wheat has been introduced the yield per acre is being increased on an average of 5 bushels.

ESTABLISHMENT OF WINTER BARLEY.—Much attention has been given this year to the introduction and development of winter varieties of barley. It is well known that fall-sown grain will yield much more on the same ground than spring-sown grain, in addition to the fact that winter grain is almost always of better quality. Excepting some Southern States, winter barley has heretofore been practically unknown in this country. After three years of demonstration work, the Tennessee Winter barley is now well established in Kansas, Oklahoma, and southern Nebraska, in addition to a few successful trials that have been made in the North Central States. The results of the introduction of this barley are remarkable and very interesting. Wherever it has been grown it is now often yielding 50 per cent more to the acre than the ordinary spring barley. Besides, it has the advantage of giving much winter pasturage in seasons that are favorable for pasturing.

The unusual success of some of our introduced Swedish and Austrian pedigreed barleys is opening up the great possibilities of pure strains of this cereal, especially for malting purposes.

DURUM WHEAT.—In the field work on durum wheat all efforts are now being concentrated on its improvement, particularly in the development first of pure types. Much help is being given in the investigations of this wheat by the experiment stations, particularly those of North Dakota, South Dakota, and Colorado. It is so well demonstrated that the Kubanka variety is the best, considering all qualities, for the northern districts that farmers everywhere thruout the North are urged to sow only this type. A number of experiments, including baking tests, all of which have been published, have proved conclusively that it is equal to the best No. 1 hard spring wheat for making bread. The results in the sale of this wheat during the last season and so far this season have been favorable far beyond expectation. Last year about 10,000,000 bushels were exported to foreign countries, and the price on an export basis at New York City and on the Canadian border was at several times equal to that of the hard spring wheat. Probably at least 20,000,000 bushels were produced in 1905, which, after making ample allowance for seed, leaves several million bushels that must have been used for bread in this country. A good portion of this was used in Minneapolis. For the crop this year a safe estimate would be about 50,000,000 bushels, or approximately one-twelfth of the usual wheat crop of this country.

From the daily and weekly reports received from the markets, it appears that about 12,000,000 bushels of this crop have so far been sold for export. This season, at New York City, durum wheat is so

far selling uniformly at 5 or 6 cents less than the same grade of Manitoba hard. The increasing export demand from dealers who know how to judge this class of wheat ought to be strong evidence of its value to American manufacturers, and it is hoped that in the future our home consumption will increase much more rapidly.

SIXTY DAY OAT.—In previous reports attention has been called to the superiority of the introduced Swedish Select oat over other standard varieties thruout the Northern States. During the same time another variety of oats has been introduced from Russia, known as the Sixty Day, but which matures, however, in a little over ninety instead of sixty days. It is so much earlier than other varieties that it often escapes many fungous and insect pests that attack other oats, as well as the effects of severe periods of drought. It is very prolific as a rule, and has an unusually wide adaptation geographically.

AMARILLO TESTING FARM.—The testing farm at Amarillo, Tex., has been in operation one year, and the fall seeding of the second year is now finished. The operations here are to a large extent in the nature of pioneer work to demonstrate to the inhabitants of the large area of the Panhandle of Texas that agriculture can actually be conducted in that region. The experiments were conducted previously at Channing, Tex. That much success has been attained in this work is indicated in the many crops that have been successfully grown thruout that territory during the last year, the farmers having been induced to sow these crops largely thru the influence of these investigations.

INVESTIGATIONS IN CALIFORNIA AND THE SOUTHWEST.—Experiments for the purpose of improving the quality of wheat in California have been conducted for two years at Modesto and Yuba City, Cal. In addition, seed of some of the most promising varieties of wheat used in these experiments has been furnished in cooperative trials with farmers in other States of the Southwest. From the results of the work so far it is evident that at least two of these new wheats are very well adapted to the southwestern United States and are at the same time good milling wheats.

CHEMICAL AND BAKING TESTS OF FLOUR AND GRAIN.—In cooperation with the Bureau of Chemistry many chemical analyses and other tests have been made of introduced grains, particularly oats and barleys, to determine their feeding value. An important piece of work has been the investigations of the comparative value of durum-wheat flour for bread making conducted for this Department by the Columbus Laboratories of Chicago.

A STUDY OF WHEAT DETERIORATION.—During the year a special investigation, also in cooperation with the Bureau of Chemistry, has been made to determine the causes of the deterioration of wheat from the milling standpoint. An important clue to the solution of this problem has been discovered, and when the matter is fully worked out it will, without doubt, enable the farmer to prevent the production of soft and light-colored grains that are much inferior in quality.

RICE INVESTIGATIONS.—A series of experiments for the thoro study of rice, its varieties, methods of handling, irrigation, etc., has been inaugurated in cooperation with the Louisiana Agricultural Experiment Station, Crowley, La., having been selected as the place of operations. More than 300 distinct varieties of rice are under experiment. The results of this season already show that a good beginning has been made in this work.

GRAIN STANDARDIZATION.

From time to time during the past five years demands have been made upon the Department for aid in the grading and handling of grain. It has been fully recognized that this is a matter which demands most careful investigation, as both our home and foreign markets are involved. Grain grading as now practised by the various State and other organized bodies has not been satisfactory, chiefly on account of the lack of uniformity. The Department has consistently held the ground that some system of standardization is absolutely necessary as a first step toward securing uniform methods of grain grading. With a view to eventually bringing about this standardization, Congress at its last session authorized the establishment of laboratories for the purpose of examining and reporting upon the nature, quality, and condition of any sample, parcel, or consignment of seed or grain entering into interstate or foreign commerce. After a careful study of the situation, two laboratories, all the funds at hand would permit, have been established—one at Baltimore, Md., the other at New Orleans, La. At both places the Department has received the cordial cooperation of the chambers of commerce, and is now about to enter upon the regular duties connected with the laboratories.

It will be the object of these laboratories to make a thoro study of present systems of grain grading with a view to reaching, if practicable, conclusions which will make standardization possible. It is recognized that much preliminary work must be done, and, furthermore, that special apparatus will have to be devised for quickly determining the moisture content of grain, and for conducting other observations and investigations. A moisture-determining apparatus has already been devised and is now in use at our laboratories. It is believed that improvements can be made in these devices and the Department's officers are already at work on this problem.

Recognizing the need for the closest relations with the grain trade, the Department has secured the services of an expert in grain grading, whose long experience should be of the greatest value in working out the many problems which must necessarily be connected with this important line of work.

DRY-LAND FARMING.

Recognizing the necessity for more systematic efforts along the line of dry-land farming, during the past year important field and laboratory investigations have been arranged for, which, it is believed, will be of great value to those who have already settled or who contemplate settling in semiarid areas where irrigation is impracticable. The Great Plains area, lying between the ninety-eighth and one hundred and fourth meridians and including approximately 330,000 square miles, is one of the most important districts where this work is being conducted.

SCOPE OF THE INVESTIGATIONS.—Thruout this vast area there is not a single State experiment station, altho there are several substations. The plan of the work is to establish special substations in cooperation with the State experiment stations in North Dakota, South Dakota, Nebraska, Oklahoma, Colorado, Kansas, and Texas. At these stations a series of tests will be carried on which will enable the State authorities and the Department to answer definitely important questions as to systems of cropping and farm management in this

extended area. The successful work already inaugurated with the durum wheats leads to the belief that there are several other crops which might also prove highly successful.

ADVICE TO PROSPECTIVE SETTLERS.—On account of the efforts made by land agents for the past two or three years to induce farmers to take up land in this region it seems proper to make a few cautionary statements in regard to this entire section of country. While there are great agricultural possibilities in the region, the fact must not be overlookt that farming there must be conducted along radically different lines from those of the more humid portions of the United States. Unquestionably many settlers have gone into this section who will be grievously disappointed in the near future. In spite of the fact that the past few seasons have given abundant rainfalls, the evidence is pretty conclusive that conditions will soon resume their normal state, which is one of semiaridity, and these conditions must be met in a way for which few farmers of the section are now prepared. It is needful to look with great caution upon the statements emanating from interested parties as to the probability of continued rainfalls and the growing of crops similar to those now commonly known to the more eastern sections of the United States.

GOOD SEED FOR THE FARMER.

Several lines of work carried on during the year have for their object the improvement of the seed upon which the farmer must depend for his crops. The investigations of seed adulterations previously mentioned in these reports have been continued, and there is every evidence that the publication of the names of firms found to be selling adulterated seed has been the means of checking the evil. In all this work the Department has but one object, namely, to protect the farmer from unscrupulous dealers who make a practise of foisting bad seed upon him. The rank and file of American seedsmen do not follow any such practises and are as anxious as the Department to protect the farmer.

A CAMPAIGN OF EDUCATION.—The Seed Laboratory has tested for both seedsmen and farmers hundreds of samples of seeds during the past year, and in this way has greatly encouraged the propaganda for good seed. A feature of the work has been a campaign of education for better seed. Cheap seed is often the most expensive thing connected with a crop. A few cents saved on each pound of alfalfa or clover seed may cost the farmer all of his work in preparing and fertilizing the ground, besides the loss of an entire season in getting the crop started. The Bureau has also been actively engaged in encouraging the good-seed work thru addresses at farmers' institutes and other meetings.

BETTER GRADES OF SEED CORN.—Special work has been done during the past year in demonstrating the great importance of high-grade seed corn. The work was inaugurated to establish the great value of proper care of the ordinary seed as grown by the farmer. The main point at issue was the gain in yield due to the vitality of the seed. Actual field demonstrations have shown that, taking corn in the average—that is, corn from different parts of the United States as ordinarily saved for seed by farmers—the yield would be increased about 15 per cent if the vitality were perfect. The Department has pointed out simple methods of testing vitality that any farmer can follow, and has shown in field practise that the adoption of such methods by the farmer may increase his yield from 10 to 15 per cent. Similar work has been conducted with a number of other crops.

WORK ON THE SUGAR BEET.

PRODUCTION OF HIGH-GRADE STRAINS OF SEED.—The work on breeding high-grade strains of sugar-beet seed has been very satisfactory during the year. This work is being conducted in cooperation with a number of experiment stations and private individuals. The first commercial crop of seed raised from roots selected under departmental supervision was harvested this year by a grower in Washington State and some 15,000 pounds of seed were secured, all from beets which, commercially analyzed by the Department, showed sugar contents of 21 to 22 per cent. In the work of selection rigid attention is given to every detail of size, color, form of root, shape of leaf, etc. The Department has received from a number of sources satisfactory evidence that the American seed which it is developing is highly satisfactory. One factory alone reports that the American-grown seed increased the yield 1.19 tons per acre on an area covering 391 acres, divided among 158 farmers. This seed was put out in competition with some of the most expensive grades of imported seed obtainable. As a line of work closely connected with the foregoing, the Department is carefully investigating and testing various varieties of sugar-beet seed imported, together with all strains of sugar-beet seed grown by American firms.

SINGLE-GERM SEED.—Very satisfactory results have been secured in the development of a sugar-beet seed which will contain a single germ. It is highly important to secure beet seed which will eliminate a considerable portion of the work of thinning. The latest returns from our investigations along this line show that our beets are averaging about 26 per cent of single-germ seed and that such seed is producing beets yielding from 16 to 17 per cent sugar. The purity coefficient is also found to be satisfactory.

The important work on fertilizers, the improvement of cultural conditions, and the extension of the sugar-beet area has been continued.

FRUIT MARKETING, TRANSPORTATION, AND STORAGE INVESTIGATIONS.

Experimental investigations of the methods of harvesting, packing, transporting, and storing fresh fruits of various kinds have been continued during the year. The fruit transportation studies have been confined chiefly to questions involved in the transcontinental shipment of deciduous and citrus fruits of the Pacific coast to eastern markets.

SHIPMENTS OF PEACHES AND PLUMS.—Experimental carload shipments of perishable varieties of peaches and plums, which were allowed to remain on the trees in California until they reached much fuller ripeness than has previously been considered safe by shippers, disclosed the fact that such fruit can be delivered in eastern markets in practically as sound condition as when taken from the tree. The superiority in flavor and wholesomeness of such sound, ripe fruit as compared with fruit either overripe and decayed or prematurely picked and wilted, which makes up so large a portion of the commercial supply of our cities, was clearly apparent. Special treatment of these experimental shipments consisted simply in the quick cooling of the packed fruit from the high temperatures which it possest when picked from the tree to a temperature of 40° to 50° F. before it was loaded in ordinary iced cars for shipment. Carloads of fruit thus treated not only required less ice in transit, but maintained more uniform tempera-

tures in the top and bottom of the car, with resultant greater uniformity of condition of contents when unloaded.

EXPERIMENTS IN CITRUS FRUIT TRANSPORTATION.—Along similar lines, but with closer attention to methods of harvesting and manipulating the fruit, a careful study of orange-handling methods in southern California was made. This revealed many interesting and important facts. It was found that the difference in the carrying quality of oranges from different producing districts in southern California was due primarily to the methods of handling practised rather than to inherent characteristics of the fruit itself. Oranges free from mechanical injuries, inflicted during the various processes of harvesting, rarely showed decay during the ordinary shipment period, even when transported without icing. On the contrary, similar fruit which had suffered from inconspicuous cuts or abrasions of the skin developed from 25 to 75 per cent of decay under similar conditions. A comprehensive series of experiments, in which fruit treated by different methods was subjected to conditions favorable to the development of decay, showed that where unmutilated fruit as it came from the tree developed but 1.5 per cent of decay, similar fruit, when dry brushed, showed 4.5 per cent, and washt fruit 10.5 per cent. The whole trend of the results of the investigation thus far indicates that complexity of methods and appliances in the handling of oranges results in increased mechanical injury and correspondingly heavy losses from decay in transit.

A study of the transportation of oranges across the continent, in which different methods of shipment were compared, showed that where oranges that had been mechanically injured were shipped under ventilation, 14 per cent of decay developed. Similar fruit shipped under ordinary icing developed 7 per cent of decay, while fruit that was precooled and shipped in iced cars developed but 4 per cent. Studies of the effect of holding the packed fruit before shipment showed that, on the average, fruit shipped the first day after packing developed but 2 per cent of decay; that shipped the third day, 3.5 per cent; the fifth, 8.6 per cent, and the seventh day, 9.5 per cent. The proportion of decay developed in the mechanically injured fruit included in the above experiments was very much above these general averages, the important fact developed being that prompt shipment after packing greatly reduces the risk in transit.

RESULTS OF FRUIT TRANSPORTATION WORK.—These investigations have had the active support of growers, shippers, and transportation interests. In the citrus industry advantage is being taken of the results of the work. Packing houses are being remodeled and simplified, the fruit is being shipped more quickly after picking. All the interests involved have shown a disposition to take advantage of the facts developed in the investigations. One of the prominent shipping interests of the Pacific coast has estimated that the work of the Bureau along this line saved the growers at least $250,000 in the season of 1905–6.

STUDIES OF FRUIT STORAGE.—In the fruit-storage investigations the cooperative study of the effect of sod and tillage on the keeping of apples has been continued with the New York State Agricultural Experiment Station, and special studies in relation to temperatures have been made in the East. The apple-storage investigations have been extended to Pacific coast fruit, considerable quantities of apples

from different California apple districts having been stored in that State and in the East for comparison. Special attention has been given to farm storage-house questions.

EXPORT SHIPMENTS OF FRUITS.—In the fruit-marketing investigations the experimental export shipment of summer apples from Delaware was continued, and similar shipments also of winter varieties from New York and Virginia. The problems connected with the exportation of winter apples to European countries are recognized as of the highest importance in this connection and are being studied as thoroly as the conditions render practicable. The importance of the apple export trade to our domestic fruit industry is shown by the fact that while the crop of 1905 was estimated to be the smallest during the past decade, the portion exported was but 7 per cent less than the average of the previous five years, constituting, as nearly as can be estimated, more than 5 per cent of the estimated total crop. Fuller information as to conditions prevailing in ocean transportation and in foreign markets is greatly needed.

The exportation of eastern-grown "Bartlett" and other early pears, which began with the Department experiments in 1901, shows a gratifying increase, the total exports of pears during the fiscal year being valued at $631,972, the larger part of which exports were of eastern-grown fruit. The beneficial effect of this export movement of pears was very evident in our markets, where good prices prevailed in consequence.

DEVELOPING NEW CROPS BY BREEDING AND SELECTION.

The Bureau's work in developing, by breeding and selection, new types of various crops has been very successful during the past year. A number of new sorts have been secured, some of which have been placed with growers and are now being grown on a large scale.

NEW CITRUS FRUITS.—The production of the new group of fruits, the citranges, or hardy oranges, is one of the most far-reaching and important triumphs which has ever been achieved as a result of carefully planned breeding experiments. Three varieties—the Rusk, Willits, and Morton—have already been named, and trees have been distributed to about 2,000 fruit growers and nurserymen, principally in the Gulf States and in Oregon and Washington. Two other new varieties have been produced, having large fruits similar in appearance to ordinary oranges, and these will be named and distributed in the near future. Both of these varieties are somewhat different from the sorts previously named, and are believed to possess superior merits in certain characters. Both are large, fine-appearing acid fruits, and are very juicy. They will prove valuable, especially for culinary purposes and in the making of acid drinks. Another variety has been secured which has fairly good fruits, and gives promise of utility as a hedge plant and lawn tree. The citranges are of special value for cultivation in regions slightly too cold for the ordinary orange, and can be recommended for planting thruout the Gulf States and in regions of low altitude in Oregon, Washington, Arizona, and New Mexico.

NEW PINEAPPLE VARIETIES.—Three of the new varieties of hybrid pineapples have this year been distributed to a number of good growers, and next year stock of all of the new varieties developed by the Department will be available for distribution. The further experiments in this field have resulted in the discovery of six more new

hybrids which possess qualities that will render them valuable for cultivation. These will be placed with growers at the earliest possible date. All of the new varieties of pineapples are superior in flavor to the ordinary varieties, and many of them have smooth or spineless leaves, a quality of considerable value to the grower. All pineapple growers who have had an opportunity to examine and test these hybrids are imprest with their superior quality and promise.

A NEW EARLY VARIETY OF COTTON.—It has been claimed by entomologists and others studying the control of the cotton boll weevil that varieties of cotton are needed which will mature their entire product very early in the season, in order to permit the crop to be harvested and the stalks destroyed early in the fall. A new early defoliate variety has been produced by an agent of the Department, working in cooperation with the Texas Agricultural Experiment Station, which possesses these qualities in marked degree and which, at the same time, is a productive sort having fairly large bolls. This new variety, the present season, ripened its fruit and matured earlier than any other of the varieties tested in comparison with it, among them being the King, which is probably the earliest variety cultivated. The new variety gives promise of being of great value for planting in boll-weevil infested regions. Several other varieties of cotton selected to secure earliness and productiveness, fitting them for boll-weevil conditions, have been under experimentation, and select seed of two of these sorts, the Edson and Triumph, will be distributed this winter.

NEW STRAINS OF CORN.—In the corn-breeding experiments great advances have been made. One variety, which has been carefully bred in central Ohio, has, for the last four years, shown an average yearly gain of 10 bushels per acre over the original variety. Seed of this variety has been sent to numerous farmers and is giving excellent results. The breeding work with sweet corn, having as its object the improvement of strains for canning purposes, has been continued with good success. It has been demonstrated that an excellent quality of sweet corn seed can be grown, and that with good care it will germinate much better and produce a better crop than such seed as is customarily purchased by canning companies.

IMPROVEMENT OF OATS.—The most promising features of the oat-breeding work are the new hybrids recently developed. These are large grained and early in season, and retain the vigor and size of the late-season parent. They bid fair to excel and eventually succeed all the early varieties now grown in the central Mississippi region. Selections for disease resistance have also been made, and the year's experiments have proved that it is possible to secure smut-resistant varieties. One selection of the Burt variety has proved to be almost smut proof.

CROPS RESISTANT TO ALKALI AND DROUGHT.—The testing of different varieties of the leading field crops with regard to their alkali resistance is being continued and extended. Much information that will permit of a choice of crop plants and plant varieties for alkali lands and provide a solid basis for the increase of resistance by breeding has been obtained. The field investigations of crop plants in relation to alkali are being supplemented by extensive laboratory experiments. As a part of the investigations of the Bureau in dry-land agriculture, the breeding of drought-resistant strains of important field crops has been taken up in cooperation with some of the State experiment stations.

PROGRESS IN TOBACCO WORK.

The tobacco-breeding experiments have proved particularly successful, and several of the new sorts produced in the course of the Department's experiments have already been planted extensively by tobacco growers, and are giving excellent results in increased yields of a superior grade of tobacco.

CONNECTICUT WRAPPER TOBACCOS.—In the work of improving Connecticut wrapper tobaccos two new hybrids have been produced—the Brewer and the Cooley. The Brewer is a hybrid of the native Connecticut Broadleaf with the imported Cuban, while the Cooley is a hybrid of the native Connecticut Havana Seed variety with the Imported Sumatra. In the hybrids the good qualities, hardiness, and adaptability to Connecticut conditions of the native varieties are combined with the superior wrapper qualities of the imported Cuban and Sumatra. The product of the hybrids has superior qualities for cigar-wrapper purposes, possessing characters which go to make up a valuable wrapper tobacco. Numerous growers have been pleased with the superior grade of tobacco produced by these hybrids and are this year growing a considerable quantity of the new varieties and selecting seed to extend their planting next year.

WRAPPER AND FILLER TOBACCOS IN THE SOUTH.—The experiments conducted in Florida in the improvement of tobacco varieties have demonstrated the value of this work to growers. Carefully selected strains of Sumatra have clearly shown their superiority, both in quality and yielding capacity, to the ordinary Sumatra-grown. The crops grown from select seed furnished by the Department to 12 different planters are far superior to the remainder of their crops and are decidedly the best crops of tobacco in the State. As a result of this demonstration of the value of the methods of selection and preservation of seed worked out by the Department of Agriculture, almost all of the large tobacco growers are this year using similar methods, and more than 50,000 paper bags have been used during the past summer by growers in covering the flower clusters of their select seed plants.

MARYLAND SMOKING TOBACCOS.—Experiments in the improvement of the Maryland smoking tobaccos have been carried on during the year in cooperation with the Maryland Agricultural Experiment Station. Selections made to secure greater uniformity and increased yields have shown striking results. The fields of tobacco grown from select seed are believed to be the best tobacco grown in the State the present season.

MISCELLANEOUS TOBACCO WORK.—One of the most important features of the tobacco-breeding investigations is the development of methods by which the grade and quality of the tobacco produced can be accurately determined. During the last year an apparatus has been devised for testing the burn of cigars accurately and another for testing the burn of strips of leaves. These machines will prove of great value in connection with the breeding experiments and probably also in the commercial testing of samples of wrapper tobacco. Investigations of the curing of tobacco have been undertaken, directed more especially toward the control of pole burn by means of artificial heat. Several diseases of tobacco are receiving attention, and the breeding of varieties for disease resistance gives promise of good results.

EXTENSION OF EXPERIMENTS.—The tobacco-breeding experiments are being extended to the tobacco-producing areas of Kentucky, Ohio,

and Virginia, and it is probable that results can be obtained in these regions as important as those produced in Connecticut and Florida. The introduction of the methods of seed selection and seed separation alone in these extensive tobacco-producing States will add many thousands of dollars to the value of the crop grown.

DRUG AND POISONOUS PLANT INVESTIGATIONS.

WORK ON CAMPHOR.—Rapid progress has been made in the investigation of camphor production, a number of camphor trees of various ages having been placed at the disposal of the Department for experimental work. More than 30 pounds of camphor were prepared, which on purification gave very favorable results. Tests of a scientific nature showed the identity of this product with that of the Orient. A careful survey of the camphor trees now widely scattered thruout Florida, and of the conditions of soil, drainage, etc., in which they occur, has made it seem reasonably clear that camphor will flourish over a large part of the area from which frost has driven the orange industry.

STUDIES OF POISONOUS PLANTS.—In the poisonous-plant investigations chief attention has been given during the year to the poisonous action of the so-called loco weeds in causing the loco disease in horses and cattle. The general outcome of this work has shown very clearly that these weeds are able to produce the symptoms characteristic of locoism and are unquestionably the chief cause of the immense loss to the stock-grazing interests of the West. Remedial measures are now being sought, as are also means of exterminating the weeds and methods of counteracting the poison.

PROGRESS IN GROWING AMERICAN TEA.

The work in South Carolina for the purpose of determining the possibilities of the commercial production of tea in the United States has progressed satisfactorily during the year. The younger gardens have given an increased yield, due in part to a change in the method of picking which was tested during the year. As a result of all influences the greatest yield during the history of the experiments was obtained, something over 12,000 pounds of dry tea. In the factory some new machinery was tested. The compression of finely ground tea into tablets was attempted with a machine of the same general type as that used by manufacturing chemists, the result being that after a few trials a hard, sightly tablet was produced which readily dissolves in hot water. The superior adaptability of this form of preparation for purposes where compactness is desired is apparent. In addition to the work in South Carolina a tea garden has been established at Pierce, Tex. The work at this point gives promise of very satisfactory results.

IMPROVEMENTS IN DISTRIBUTING NITROGEN-FIXING BACTERIA.

The method of distributing cultures dried on cotton for the inoculation of leguminous crops was discontinued during the year, and in its place the plan adopted of distributing pure liquid cultures hermetically sealed in glass tubes. This has been proved to be a great improvement over the old system. It is planned to distribute during the current year larger cultures to the farmers, and thus render it possible to reduce the time formerly required to develop a rich culture for inoculating leguminous crops. Many field tests in this work are

under way on large farms, and it is hoped by this careful experimental work to acquire much valuable information concerning the best manner of treatment of certain soils and crops in order to obtain successful inoculations.

WORK ON WATER CONTAMINATION.

The work of the Bureau of Plant Industry in the treatment of water supplies with copper sulfate for the destruction of algæ and pathogenic bacteria has past from the experimental stage to that of actual practical use. Investigations of the use of copper sulfate in sewage disposal have indicated that in small sewage plants the use of copper will make it possible to produce sewage effluents that are entirely free from pathogenic bacteria. Work is being planned to test the efficiency of copper in connection with filtration. Additional work is to be carried on thruout the United States in order to determine the value of copper in various types of water. The copper treatment of water supplies, sewage disposal, etc., should in all cases be supervised by an expert. Before this method of purification is attempted the conditions must be worked out on a scientific basis in each instance.

FARM-MANAGEMENT INVESTIGATIONS.

The farm-management investigations during the past year have been carried on along two principal lines, namely, the study of farm practise and demonstrations in improved methods. The object of the first is to make a careful study of farm methods as followed by successful men in different sections of the country and representing different types of agriculture. These studies lead to the securing of data which enable the Department to assist farmers and others in planning methods of cropping and maintaining soil fertility. In connection with this work special attention has been given to crops adapted to new sections and to the relation between certain improved crops and soil fertility. Alfalfa has been found to be adapted to an important soil formation in Alabama and Mississippi, and is rapidly becoming a valuable crop of that section. This soil is heavily charged with lime. In this connection the Bureau of Plant Industry follows closely the work of the Bureau of Soils in its soil mapping. A special study has been made during the year of the practises of farmers in the East who have been successful in growing alfalfa.

METHODS OF STORING SILAGE.—In connection with the studies of farm practise, a special investigation has been made during the year of methods of storing silage. The kinds of crops used for silage, the cost of growing and of siloing them have all been considered.

CONTROL OF JOHNSON GRASS.—The farm-management investigations also deal with the question of weed control. It is believed that data have been secured which will enable the farmer to control Johnson grass and utilize it in a satisfactory way in crop rotation in the South. The secret of success in this work lies in the fact that in a Johnson grass sod left undisturbed for two or three years the rootstocks are found only at the surface. In this condition the pest is easily destroyed by shallow plowing and a little extra cultivation the next summer. This permits Johnson grass to be grown in a rotation, such as cotton, corn and cowpeas, winter oats, and Johnson grass for two years. Where the pest is allowed to grow on land that is cultivated in cotton

or corn the rootstocks penetrate deeply into the soil and eradication is extremely difficult.

CACTUS-FEEDING EXPERIMENTS.—Investigations into the value of cactus as food for cattle have been continued. A carload of steers were fattened on cactus and cotton-seed meal, at a cost of 3½ cents per pound of gain. As a feed for dairy cows 6 pounds of fresh cactus equaled 1 pound of sorghum hay when fed with a mixture of grain and mill stuff.

OBJECT-LESSON FARMS.—The object-lesson farms referred to in former reports have been continued. As the result of the work on one of these farms, many farmers in Alabama have sown alfalfa and are thus preparing for the advent of the boll weevil. The great advantage of pasturing hogs on alfalfa in that section has been demonstrated. In order to meet the demand for object-lesson farms in the South the system of establishing these farms has been changed. Instead of assuming close supervision of the farms, working plans are now prepared. This enables the Department to reach many more localities than were possible under the former system.

Nearly all successful farms are unique in their management. They represent systems wrought out by men of unusual energy and intelligence who have gone resolutely about discovering and utilizing the full possibilities of their land. From such men we are learning facts which when properly classified will constitute the art of farm management. These farms demonstrate the great value of intelligent management, as compared with hard work applied unintelligently.

SPECIAL WORK ON COTTON.

The special work on cotton which has for its object the meeting of the ravages of the boll weevil in the South has been continued along pretty nearly the same lines set forth in my last report. The cooperative work with farmers has been a special feature and has been extended into Louisiana, Mississippi, and Arkansas. This work is now carried on in the States mentioned, and in addition special attention has been devoted to Texas, which is in the heart of the boll-weevil infested territory. Experience has enabled the Bureau of Plant Industry to systematize the work so as to reach practical farmers and secure their interest and cooperation. It is estimated that thru this work the Department is now reaching, directly and indirectly, in the neighborhood of 100,000 farmers in the States mentioned.

The plan is a simple one, and from its very simplicity is found to be effective. Meetings of farmers are held in different communities and arrangements made whereby representative men agree to handle a part or all of their land with the advice and assistance of the Department's agents. No radical recommendations are made in the matter of changing the existing systems, unless such systems are known to be bad. The varieties of cotton known to be best adapted for boll-weevil conditions are recommended and planted. Systems of fertilization are suggested and, wherever practicable, diversification is encouraged. The farmers who are cooperating with the Department in the work receive regular visits from our agents and, in addition, furnish weekly reports setting forth their operations and the results. At the end of the season there is, as a rule, a demonstration as to the effectiveness and value of the systems laid out as compared with the old methods. A special point which the Department makes in all this work is that no radically new methods are being urged. We

simply endeavor to have put into practise methods which are already known to be highly successful, encouraging the farmer himself to take the leading part in the work.

The breeding work, having for its object the securing of types of cotton better adapted to boll-weevil conditions, has already been referred to under the head of plant-breeding investigations. As a part of this special work on cotton, investigations of root rot have been continued, the same being largely field studies to determine the value of crop rotations in eradicating the pest from the soil. Investigations of cottons found in Guatemala and other southern countries have also been continued and some interesting results secured. Some of these cottons give promise of proving valuable for use in connection with breeding work. Having developed for a long series of years in combat with the boll weevil, they have characteristics quite different from any types of cottons which we now possess.

DEPARTMENT GROUNDS AND ARLINGTON FARM.

The Department grounds, consisting of 40 acres, are now in a well-developed state. During the year all the roads have been improved, a special appropriation of $3,500 being used for the purpose. The glass houses on the grounds have been further improved and are now being used for many lines of work carried on by the Bureau.

At the Arlington Experimental Farm there are about 350 acres under cultivation. Many varied lines of work are being carried on, including the testing of foreign crops, variety tests of all seeds and plants sent out, cover crops for orchards, variety orchard and other fruit tests, etc. The farm now has a well-equipped range of glass houses for experimental work and all the newer portions of the land are being brought into good tilth by the use of proper management and green manures.

CONGRESSIONAL SEED DISTRIBUTION.

The Congressional seed work for the year has been conducted along practically the same lines as in the past. The number of packages of miscellaneous vegetable and flower seed sent out during the year was about 7,000,000. There has been no change in this number during the past five years.

FIELD LABORATORIES AND TESTING GARDENS.

At its Mississippi Valley laboratory, located at St. Louis, Mo., the Bureau of Plant Industry has conducted investigations of many of the diseases which affect forest and fruit trees in that region. Methods of treating fence posts have also been worked out during the year. Considerable attention has been given to the crown-gall disease of orchard and other fruits, with the object of finding a means for preventing the further spread of the disease. The results obtained have shown that the crown gall of the apple tree can be very largely prevented by careful attention to root grafting and by subsequent wrapping of the grafts with cloth, rubber, or paper. It has been found that this type of the disease is not contagious, while, on the other hand, the crown gall of the grape may be transmitted thru the soil and may be spread by irrigation water from one vineyard to another. American varieties of grapes have been found to be very resistant to the disease, and the most probable method of its control will consist in the grow-

ing of resistant varieties. Further proof has been obtained as to the contagious nature of the crown-gall disease of stone fruits.

In the work on various diseases of forest trees, an investigation of the diseases of red gum has been continued at various points in the Mississippi Valley. The diseases of the living tree were investigated, particularly the form of rot which destroys thousands of feet of gum timber every year after it is cut. A large quantity of timber was given a treatment as a preliminary test to ascertain whether this destruction could be prevented. The treatment showed an increase of 20 per cent in the amount of lumber cut, meaning almost a total prevention. The methods of treatment worked out are being tried by lumbermen on a commercial scale.

At the Subtropical Laboratory, Miami, Fla., the Bureau is conducting investigations of the diseases affecting tropical and subtropical plants, such as the mango, avocado, and citrus fruits. Methods have been worked out for the control of these troubles. Experiments in the propagation of tropical and subtropical fruits are also being conducted at this laboratory.

The Bureau of Plant Industry is carrying on at its Plant Introduction Garden, located at Chico, Cal., experiments in the propagation of many seeds and plants introduced from foreign countries. Trials of forage crops and vegetables suited to the Southwest are also being conducted at this garden. Twelve acres at the garden have been set aside for experimental work on European grape varieties, 4,180 cuttings having been rooted during the past season. A number of these were distributed during the past spring among the experimental vineyards maintained by the Bureau in different parts of California. Experimental work in the propagation of figs and of the pistache nut is also being carried on at the garden and with growers in the Southwestern States.

In addition to the foregoing, the Bureau is conducting an experimental farm at San Antonio, Tex. The object of the work at this farm is to test new crops likely to prove of value to the region represented, and to find the best methods of tillage by which the relatively large but irregular rainfall of the region may be utilized in the profitable production of the staple crops.

FOREST SERVICE.

NATIONAL FOREST RESERVES.

The fiscal year 1905–6 was and will remain notable in the history of the Forest Service for the progress made in actually applying a National reserve policy. In area the reserves were increased during the year from 85,693,422 to 106,999,138 acres. In revenue the reserves brought in $767,219.96, as against $60,142.62 for the previous year, and $58,436.19 for the year 1903–4. In timber sales there were disposed of for immediate or early removal nearly 300 million board feet of lumber at stumpage prices ranging up to $4 per thousand (besides other material to a large value), as against 96,060,258 board feet, with a maximum price of $2.50 per thousand in 1904–5, and 69,257,710 board feet in 1903–4. The number of free-use permits granted in the same years also showed progressive increase. In the year 1904–5 the reserves were under Forest Service control only after February 1.

One fiscal year of full control has established two important facts—that the reserves advance the present interests of the people of the West and that they will speedily pay the cost of administering them.

PUBLIC UTILITY OF THE RESERVES.

These National forests are being made useful now. The benefits which they are to secure are not deferred benefits. Thru Government control the interests of the future are safeguarded, but not by sacrificing those of the present. Far from handicapping the development of the States in which they lie, the reserves will powerfully promote development. They work counter to the prosecution of no industry, and retard the beneficial use of no resource.

The wealth of the West lies, and will long lie, in what the soil will produce and in what the earth hides. Labor and capital will here find employment mainly in turning to use the farm land, grazing land, timber land, and mineral lands of the region, and in the commerce to which these great productive industries will give rise. That the reserves beneficially affect all of these industries is becoming clearer to the people of the West every day, and in consequence the policy of public administration of our unappropriated timber lands becomes more and more firmly established in the approval of a united public sentiment. Local sentiment has sometimes been unfavorable to the creation of reserves before their effect upon the public welfare was understood; but opposition has always dissolved under the test of actual experience.

The reserves do not withhold land from agricultural use, but greatly increase the amount of available farm land. Tho they were made from the most rugged and mountainous parts of the West and were intended to include only land unsuited for agriculture, by the act of June 11, 1906, the right is given settlers to homestead within the reserves wherever strips and patches of tillable land can be found. At the same time, thru their water-conserving power, these forests fix in regions of scanty rainfall the amount of land which can be brought under the plow, since at best much otherwise fertile land must go uncultivated for want of water. Without forest preservation much of the land now under irrigation would have to be abandoned again to the desert. Thus the promotion of agriculture is one of the main ends of the forest-reserve policy.

Mining in the West is mainly in regions surrounded by reserves or included within them; but the reserves do not impede the development of mineral resources. On the contrary, by guaranteeing future supplies of timber they are indispensable to the future development of these resources, as the great mining interests well know. They do not interfere with the prospector, who has the same right to prospect and locate in forest reserves that he has on any other part of the public domain.

Administrative control of the forest reserves is beneficial to the grazing industry. The sentiment of stockmen thruout the West is unitedly in favor of such control, because of the gain to them now that the reserve ranges are safe from overcrowding and deterioration. Thus the rights of the individual user are respected and the permanence of this great resource is assured. I wish to commend particularly in this connection the heartiness and good spirit with which the associations of western stockmen have cooperated in our efforts to enforce fair and just measures for the regulation of grazing in the interest of

all users of the forests, and in the interest of the public, to whom these forests belong. The charge of a grazing fee, made for the first time during the past year, tho reasonable in view of the advantages of grazing regulation to the stockmen and the cost of reserve administration to the Government, and justly due in the interest of the public, might have been expected to cause dissatisfaction and friction. On the contrary, as soon as the reasons for the charge and the method in which it would be applied had been explained, it was generally approved and paid willingly and promptly. It was followed by no falling off in the number of stock grazed in the reserves. In some cases the associations of stockmen have voluntarily aided the Service in settling local difficulties. Their whole conduct has shown remarkable moderation, far-sightedness, and readiness to recognize and accept what is in the permanent interest of their industry, even tho it involves the sacrifice of immediate personal advantage.

Finally, Forest Service administration of the reserves is beneficial alike to the lumber industry and to the timber-consuming public. There is now standing on the reserves not less than 300 billion board feet of merchantable timber. This is not locked up from present use as a hoarded supply against future needs; it is ready for the immediate demands of a developing country. It will not be rushed upon the wholesale market in competition with the cheap stumpage prices of private owners anxious for ready money, and it will not be disposed of under a short-sighted policy of utilization which would leave a gap between the end of the present supply and the oncoming of the second crop; but it is and will continue to be available, first for the small user—home-builder, rancher, or miner—and then for the needs of lumber concerns, large miners, and railroads, for which a timber supply is indispensable, and which in turn are indispensable to the prosperity of the West.

The supply of timber furnished by the matured crop now on the ground is so vast in proportion to the present demand that there might seem to be no need for caution in its use. Were no more cut than last year it would suffice for four hundred years. In the mature forest production is at a standstill, so that from the point of view of the largest possible production of timber lumbering under such methods as will insure a second crop is highly desirable. The demand upon the reserves, however, is as yet insignificant in proportion to even the present need, most of which is met by the supply from private holdings. The reserves form the heart of the western timber lands. They are generally less accessible than the private holdings which surround them, and would naturally form the last resource of the lumberman. They must be so maintained as first of all to be ready to meet the future demands of the regions in which they lie. With a growing population and expanding industries these demands will far exceed those of the present. The crucial problem of management will be to insure a timber and water supply for the great West, and to conserve the summer stock ranges. To meet it successfully will require careful foresight and the best technical information. Timber sales are now made with strict attention to the welfare of the forest, and at stumpage prices often decidedly in advance of the market.

THE RESERVES SELF-SUSTAINING.

The income from the reserves is as yet but a small fraction of what may be expected as they approach full utilization. Yet their adminis-

tration is already on a sound business basis. Not only are they meeting from their receipts a very large part of the cost of their maintenance; they are even now beginning to show a decided decrease in net expense to the Government. My estimate of the appropriation necessary to meet the general expenses of the Forest Service is less by $100,000 than the appropriation of last year, notwithstanding that the total area of the reserves has been substantially enlarged by Executive action; that increasing use necessitates greater expense of administration, and that in general the work of the Service is growing very rapidly. Tho the administration of the reserves forms but a part of the field of work, it may confidently be expected that within five years from the transfer of the reserves to this Department the Forest Service will cost the taxpayer nothing whatever.

In reaching this result no unjust burden will have been laid on any interest. As public property the National forests should yield to the public a reasonable return for whatever of value private individuals secure from them for their own profit. In accordance with this principle, applicants for special privileges—as rights of way, reservoir sites, power-house sites, and similar concessions—have been called upon to pay for such privileges on the basis of their commercial value. For example, in the case of water powers duly located under the State laws, but which can not be developed without the occupancy of reserve land, besides a charge for the land occupied, based on its value as forest land, a small charge per unit of power developed is made, not for the use of the water itself, which is granted directly by the State but for the conservation of the supply which the preservation of the forests furnishes, and which, were it not for the existence of the reserve, the water-right owner could secure only by himself acquiring great bodies of forest land. Such a charge is essentially similar to the charge for stock grazed upon the reserves. It is a return for actual value received, and throws upon those who profit by public control of the reserves a share of the cost of maintaining that control.

By the wise and just provision of Congress in enacting at its last session that 10 per cent of the gross receipts from the National reserves shall be made over to the several States in which they are situated, for the benefit of the counties which would otherwise receive no revenue from a part of their area, a real grievance was redrest. Even with the present use of the reserves the benefits thus reaped from them by the communities in their neighborhood are of substantial importance. As time goes on the importance of this provision will increase, and eventually the counties will find themselves far better off than they would have been without the reserves, for private ownership followed by exploitation would have destroyed the sources of revenue by leaving little or nothing of permanent taxable value, whereas now every resource is conserved and will be made to pay its just share of income. Since the fundamental purpose for which reserves exist is to secure the best permanent use of all resources, their effect is to add to property value, and by turning over 10 per cent of their gross receipts to local use they will contribute far more to the local public needs than the taxes they would pay if they were private property.

Protection of the reserves from fire has been the most important task laid upon the Forest Service. It is cause for congratulation that the loss by fire during the year was so slight. Indeed, the saving which resulted from the organized care of the reserve force was undoubtedly worth more than the whole cost of administering the

reserves. Only about eight fires of any consequence occurred on the reserves during the calendar year 1905, a season of extreme dryness and one in which under ordinary circumstances the damage from fires should have been unusually large. This small number was due in large part to the system of patrol, which leads to the discovery of fires before much damage has been done. So far during the calendar year 1906 the damage from fire has been extremely small, even in comparison with that in 1905. Increased efficiency of the patrol system, combined with favorable climatic conditions, has led to this favorable result.

WORK OF THE YEAR.

FOREST MANAGEMENT.

The progress made by the Forest Service in the brief period of seventeen months, during which it has had charge of the reserves, in introducing management upon a vast field of operations in virgin forests of varied types, compares favorably with anything that the history of forestry can show in any country. From Minnesota to southern California and from Washington to New Mexico, reserve timber is now being cut under regulations looking to a second crop. With larger experience the methods now applied will doubtless be found faulty in some respects, and with opportunity for more intensive use which the rising value of timber will afford, much more satisfactory results will be possible; but the important fact is that, confronted with a problem of unexampled magnitude in its kind, the Forest Service proved able to substitute conservative for destructive use, while greatly increasing the use itself.

Live timber is cut on the reserves under stipulations based on actual study of the forest conditions to protect the forest and the water supply from injury. Piling of the waste left by logging is always required, a diameter limit is set to prevent too heavy cutting, seed trees are left where necessary to provide for reproduction, full utilization of all salable material is compelled, and young growth is protected from injury. All this the purchaser is under contract to perform, under the supervision of the forest officers, who are held to efficiency by systematic inspection. Yet in spite of these requirements, which slightly reduce the profits of lumbering to the purchaser, record stumpage prices have often been obtained, and the average price realized has been far above that usually paid in the same regions. Living trees to be cut are marked beforehand by the forest officers, who also scale the lumber before it is removed.

Tho some large sales of timber have been made in regions where great quantities of mature forest were available and exposed to deterioration, the constant policy has been to encourage the small user. Besides the free-use permits, in more than 99 cases out of every 100 the sales were of less than 5 million board feet.

Receipts for the sale of timber on the reserves were nearly $250,000, while the contract sales of the year reach a total of over $500,000. Five years is the longest period allowed under these contracts in which to cut the timber sold. Timber which can be harvested with profit only by large operations and with a heavy outlay for the construction of a milling plant or means of transportation, or both, must necessarily be sold under a contract extending over several years; but no sales are made permitting the speculative holding of timber against a rise in market price.

The largest totals of sales by States were in South Dakota (73 million board feet), Wyoming (71 million feet), and Montana (over 53 million feet). In the latter two States heavy lodgepole pine forests are ready for the ax, but difficult to lumber from their inaccessibility. At the same time a sudden demand for lodgepole pine railroad ties has opened a market for this timber and made it possible to sell by large contracts under conditions which will permit a second cutting after thirty or forty years. In South Dakota a special reason exists for pressing the sale of timber with the utmost energy. By the ravages of a bark beetle great quantities of timber are being destroyed, and the annihilation of the entire forest of the region is threatened. Only by extensive cutting of infested trees can the spread of the beetles be checked and the damaged timber be utilized.

In Colorado and Arizona sales of timber totaled over 27 million board feet for each State, and in Utah and California over 10 million. In Colorado and Utah these sales were mainly of fire-killed timber, largely used in mining. In Arizona large quantities of mature accessible timber permitted extensive cutting without injury to the forest. In other States cutting was comparatively insignificant in amount, save in Idaho, where nearly 9 million feet were cut.

Little difficulty was experienced in preventing timber trespass upon the reserves. Where such trespass occurred the full value of the timber taken was recovered. Practically no loss was sustained from theft.

COOPERATIVE MANAGEMENT.

The Forest Service continues to receive applications from private owners for assistance in introducing forest management upon their holdings. So far as possible the Forest Service will give aid in this work as in the past, since it is plainly in the public interest to promote the practise of forestry among private owners on business principles. It is significant that while at the first it was necessary to prepare a working plan for every timber tract before recommendations for conservative management could be made, during the past year, out of 54 timber tracts examined, it was possible on 43 to outline at once a system of management and the regulations to put it into effect. Working plans were made during the year for 6 large tracts in New York, Kentucky, Michigan, and South Carolina, and for 100 woodlots in 16 States.

In the woodlot work, which assists small owners, particularly farmers, to make the best use of their woodland, special attention was given to the Middle West. Very different problems are here presented from those of the Eastern States, hitherto the main field of woodlot study. As the need of timber becomes more pressing, the yield from these small forest areas, which nevertheless in the aggregate form a large part of our total woodland area, will become increasingly important. On the whole, the farmer knows how to utilize his woodland far less intelligently than any other part of his farm. If he can be brought to an early realization of the future value of good timber and knowledge of how to grow it, great benefit will result, both to the farmer and to the community, which later will stand in need of every available supply.

Cooperative forest studies were carried on during the year with the States of California, New Hampshire, and North Carolina; with the

Office of Indian Affairs of the Department of the Interior, on the Wisconsin Indian Reservation; with the War Department, on the military reservation in New Mexico; and with the Hydrographic Division on the United States Geological Survey, upon the Potomac River watershed. Tie production in Wisconsin and Minnesota, in cooperation with the Northern Pacific Railroad, and the effect of sulfur fumes from smelters on neighboring forests in Tennessee, in cooperation with private forest owners and with the Bureaus of Chemistry and Entomology, were also studied.

FOREST EXTENSION.

The field of forest planting in the United States broadens with every year. In the East the economic conditions are bringing rapidly nearer intensive forest management, which will involve extensive planting, both to stock the land fully and to shorten the interval between crops. In the Middle West the rising value of lumber is tending to make the growing of trees profitable on land now in pasture or under the plow. Knowledge gained by past investigations of how to make trees grow under adverse conditions opens enlarged possibilities to private owners in the more arid parts of the far West. By far the most important part of the field, however, is that of reserve planting. Here in the future a gigantic task will be presented, upon which the Forest Service has already begun a preliminary attack. Planting will furnish a future timber supply, improve drainage basins, and replace inferior species with more valuable trees. Of the 107,000,000 acres of reserves enormous areas are partly or wholly unforested.

In the Middle West alone are 5 reserves, aggregating over 750,000 acres, which are practically treeless and on which planting is now under way. Doubtless future additions to the reserves will still further increase the task. While some of this land may never support trees, the public welfare will eventually demand that the larger part of it be forested. Unaided natural reproduction can never accomplish the task in time. As the need for wood and water increases, planting on a scale as yet entirely unthought of in this or any other country will be carried on.

For private planting the two most serious obstacles to widespread activity are the high cost and the poor quality of both the nursery stock and the tree seeds now commercially obtainable. In some cases eastern tree planters have been compelled to import from Europe nursery stock of American trees, and adulterated seeds are common on the market. It is not possible for the Forest Service to supply nursery stock for private use, but it is doing what it can to aid the planter by tests of the purity and germinative powers of seeds furnished by different dealers, and by information as to prices at which seeds and stock may be obtained in different regions.

For planting on the reserves the Forest Service must raise its own material. Six planting stations are now established, with an annual capacity of 6,000,000 seedlings. Yet to plant 1 square mile requires more than 700,000 seedlings. Tho four years have past since the first nursery station was established, the work as yet done has been hardly more than experimental, and in the newer nurseries few of the seedlings are old enough to plant out. To meet the needs of the reserves, preparations for planting must be made on a vastly greater scale.

As a first step, nursery sites will be established at rangers' headquarters on all the reserves. As rapidly as possible the reserve force will be trained to carry on this work, and nursery stations will be multiplied.

The real progress made toward reserve planting appears not in the number of trees set out or the present capacity of the stations, but in the fact that practical methods of doing the work at reasonable cost have been found. In spite of the high cost of labor in this country, an acre of land can now under ordinary conditions be planted to forest by the Service almost as cheaply as the same work is done in Germany. The whole problem of successful forest planting under the conditions of aridity, elevation, lack of transportation facilities, and scarcity of labor, combined with the lack of any experience which could guide to right action, was one of extreme difficulty. Tho much yet remains to be done before a perfected system of planting will have been secured, the work now done amounts to a demonstration that success is within reach. This in itself is no small achievement.

COOPERATIVE PLANTING.

The Forest Service cooperates with private owners to secure forest extension by preparing planting plans for them. Two years ago the average size of the planting plans made was 68 acres. Last year it was 310 acres. This is significant of changing conditions. Increasingly as the necessity of provision for the future needs becomes plain, large owners are seeking the cooperation of the Service. A number of railroads have begun to plan for tie production from planted timber; coal companies are preparing to utilize waste land, and cities are seeking to improve their watersheds and at the same time derive a revenue from the land held for watershed protection.

Examinations were made of over 300,000 acres on which the owners wish to consider planting, and detailed planting plans were made for over 10,000 acres in 19 States.

Cooperation with other Departments, by the preparation of planting plans, included the War Department, the Bureau of Fisheries of the Department of Commerce and Labor, and the Reclamation Service of the Department of the Interior.

DENDROLOGY.

The investigation of turpentining methods was pushed along lines which promise important economic results by diminishing the wound inflicted on the tree and greatly prolonging the period during which a tract may be worked. A chemical study of the turpentine from different species of pines (conducted in cooperation with the University of North Carolina) is under way to learn which species furnish the most valuable yield.

Studies of forest distribution and resources were continued. The experimental basket-willow holts demonstrated the success of the cultural methods advocated by the Service by producing a crop of rods of the finest quality. Analyses of willow barks established their value for use in tanning. By the identification of many samples of woods valuable information was furnished wood users.

FOREST PRODUCTS.

An important means of reducing the drain upon our forests is the treatment of wood by seasoning, by the use of chemicals, or by both

combined, to make it last longer. Careful experiments are under way to determine the most effective and economical methods of treating railroad ties, telephone and telegraph poles and cross arms, and fence posts. Material cut at different times of the year, seasoned at different times of the year, and by different methods, and treated by different processes is being tested in service to find out how it can be made most durable.

Wood distillation to utilize the waste product of lumbering, and the suitability of untried woods for making paper pulp, were made the subjects of special studies.

Over 12,000 tests of the strength of timber were made. The woods tested include loblolly pine, red fir, western hemlock, Norway pine, tamarack, white and red oak, and eucalyptus. By these tests, which show the suitability of the various kinds of wood for different uses, both timberland owners and those who employ wood in building and manufacturing have received great benefit. New woods have been brought into use and economy in the use of material has been promoted. The present facilities for this work are inadequate, and it is important that a special laboratory be provided at Washington.

By statistical study of the production and consumption of lumber in various forms and compilation of the various grading rules now in use, information greatly desired by the lumber trade but never before obtainable was gathered, better conditions were promoted, and light was thrown on the highly important question of the probable duration of the country's lumber supply. Special studies of the manufacture of cooperage stock, of vehicles and implements, and of boxes, and of certain kiln-drying methods, gave results of decided value both to the manufacturers and to timber-land owners. Wood as a paving material was also studied, and experiments were started to discover the best kinds of wood to use and how they should be treated and laid.

BUREAU OF CHEMISTRY.

The activities of the Bureau of Chemistry during the year included a great variety of investigations.

EXAMINATION OF BUTTER, MILK, AND CREAM.

More than 800 samples of butter were investigated, to see if they complied with the requirements of the law relating to renovated butter. A study of the effects of cold storage upon the chemical composition of milk and cream was inaugurated, to determine the length of time during which such products can be safely kept in cold storage.

CEREAL INVESTIGATIONS.

The effect of environment upon the content of sugar in Indian sweet corn was studied. The almost universal use of sweet corn for food thruout the country renders such an investigation of peculiar interest to consumers as well as to producers. A single variety of seed was planted in different localities from South Carolina to Maine, and the quantity of sugar in the product was carefully determined. At the same time meteorological data were secured which are utilized in determining the effect of environment in all of its factors upon the composition of the product. It was found that within twenty-four hours after harvest, if exposed to ordinary temperatures, a very considerable percentage of the sugar has disappeared from the grains of

the corn. This fact has led to the observation that it is necessary to market the product as soon as possible after harvest, and meanwhile to keep it at as low a temperature as can be secured.

Studies looking to the improvement of the different varieties of Indian corn, by selection based upon analytical data, were undertaken. These studies are a continuation of those conducted the preceding year upon the effect of environment on the chemical composition of the sugar beet. In all, over 3,000 analyses were made of cereals in the prosecution of the above investigations. These investigations also include the effect of environment upon the chemical composition of barley as related to the brewing industries.

STUDY OF DENATURED ALCOHOL.

An important investigation was also begun upon the economic production of alcohol from various raw materials in relation to the production of denatured alcohol for industrial purposes. The object of this investigation was to discover the value of various waste materials of factories—wood, molasses, sweet potatoes, cornstalks, etc.—in the production of alcohol for denaturing. This work is likely to prove of great value to our farmers in developing new sources of income from the production of denatured alcohol for industrial purposes.

TESTING OF SUPPLIES FURNISHED UNDER CONTRACT.

In the Contracts Laboratory, the object of which is the examination of materials furnished to the different Departments of the Government under contract, 69 samples were examined for the War Department, 19 for the Navy Department, 65 for the Department of the Interior, 36 for the Treasury, 73 for the Post-Office, 1 for the Department of Commerce and Labor, 73 for the Government Printing Office, and 59 for the Department of Agriculture. These examinations were of the most rigid character, and the result of the work has been to secure a much higher quality of material than was formerly supplied under the contract system.

EXAMINATION OF DRUGS.

The examination of drugs has been particularly fruitful during the year. Five hundred and fifty-three samples were examined for purity and quality. A large part of the work of the Drug Laboratory has been in connection with the Post-Office Department for the purpose of suppressing traffic in fraudulent preparations transmitted thru the mails. As the result of these investigations a large number of fraud orders has been issued forbidding the use of the mails for such purposes. Other important investigations were undertaken in the testing of chemical reagents, of oils and essences, and of plant drugs.

ANALYSIS OF WATERS, INSECTICIDES, AND CATTLE FOODS.

The examination of waters used as beverages has been continued, and also the analysis of waters used for irrigation. Thirty-nine samples of insecticides were investigated during the year. Studies were made also of the lime-sulfur-salt wash and allied mixtures. One hundred and fifty-four samples of cattle food were analyzed to determine the quality of the cattle foods sold upon the markets. Studies

were also made of the injurious effects of fumes from smelters upon vegetation, and testimony was given in the courts relating thereto. It is evident that the sulfurous acid fumes produced in most smelters are of a character to injure vegetation and also animal health in a region very widely extended about the factory. It appears probable that in the near future smelters will be required to convert the sulfurous acid into sulfuric acid or some other substance which will not cause the injuries above mentioned.

STUDY OF TANNING MATERIALS, PAPER, AND TURPENTINE.

The study of tanning materials was continued, especially of the Sicilian sumacs. The effects of different tanning materials upon the character, quality, and durability of leather were investigated. Investigations of great importance, not only to the various Departments of the Government but to the people in general, are those relating to the character of paper used for public records. Investigations have been continued respecting the composition of turpentine distilled from wood and its relations to the ordinary turpentine.

FOOD INSPECTION.

The food and drugs act, June 30, 1906, imposes upon the Department additional duties of a most important character. The two chief purposes kept in view by this act thruout all its sections are, first, to prevent the introduction of any injurious or debasing substance into foods or drugs, and, second, to secure the correct labeling of all food and drug products. This act applies to all interstate and foreign commerce in all foods and drugs, and also to all imported meat food products. The proper enforcement of this act must prove of immense benefit to all the people of this country in securing freedom from adulteration and fraud. Regulations providing for the administration of the law have been carefully prepared, and 30,000 copies have been distributed throughout the country.

The inspection of imported foods at the ports of entry has been extended, especially at New York, Boston, and Philadelphia. The earthquake and fire at San Francisco in April unfortunately destroyed our laboratory at that port. It is hoped that this enforced suspension, however, will not be of long duration.

Five thousand seven hundred and forty-nine samples of imported food products were examined during the fiscal year. Of the 1,246 samples which were found not to comply with the law, 531 were released without prejudice because it was evident that no intent to defraud or deceive the people of the country existed; 577 were admitted after being relabeled so as to comply with the provisions of the law; 138 invoices were required to be reshipped beyond the jurisdiction of the United States. In addition to the above number of samples, 8,735 inspections were made upon the floors of the appraisers' stores.

The effect of the food-inspection law on foreign commerce has been most salutary. In many cases kinds of food products which were formerly very generally misbranded are now found to be almost universally free of suspicion. There has been a very decided improvement in the quality of imported food products, due to inspection.

FOOD STUDIES.

The Division of Foods has also conducted special investigations into the extent of domestic adulteration of food products and an investigation of tropical and subtropical fruits, as well as of fruits of domestic production.

A very extensive investigation made to determine the character of distilled liquors, both those imported into the United States and those of domestic manufacture, has been practically completed.

The study of the effects of colors, preservatives, and other substances added to foods has been continued during the year, and most valuable data relating thereto are now being prepared for publication. This investigation is particularly valuable because the experiments are made upon human beings.

MICROSCOPIC WORK.

The microscope has become one of the most valuable adjuncts in the examination of food products and materials used for technical purposes. Micro-chemical investigations have been largely made in the work of the Bureau of Chemistry and have extended not only to foods but also to leathers, papers, tanning materials, and bacteriological examinations. The total number of samples examined during the year was 1,067. The bacterio-chemical work has been of extreme importance. This is especially true in connection with the work authorized by Congress on the effects of cold storage upon wholesomeness of food products. Particularly in investigating the relative merits of drawn and undrawn fowls when placed in cold storage, the bacterio-chemical examination is of vital importance. Studies have therefore been made to determine whether the bacteria of the intestinal tract migrate to the flesh of the fowl during the period of cold storage, and, if so, what chemical changes are produced thereby. The bacterio-chemical investigations have extended to a large number of other subjects, particularly to the chemical changes which take place in milk, cream, and evaporated and condensed milks, and to the general changes of a bacterial character which foods undergo on keeping.

BUREAU OF SOILS.

Underlying all attempts to improve the general agricultural welfare of the country lies the necessity for a correct knowledge of the character and variety of its soils. Such knowledge is fundamental, and without it no great progress can be made in securing further diversification of crops, the introduction of new crops, or the more economical production of the great staples now known.

THE SOIL SURVEY.

Since 1899 the Bureau of Soils has been conducting an investigation of the soils of the United States which will ultimately result in a thoro familiarity with the vast, varied, and but partially appreciated soil resources of the country. The purpose of this work is to ascertain the variety and extent of the chief characteristic soils of the country, to determine the crop or crops which can be raised to the best advantage upon each of these soils, and to discover what peculiarities of soil management are best suited to secure the maximum results on each soil in different and widely separated localities.

EXTENT OF THE SURVEYS.

During the fiscal year 1906 soil surveys covering 19,341 square miles, or 12,370,240 acres, were made in 29 States and 2 Territories. In all, to June 30, 1906, 251 different surveys have been made in 43 States and 4 Territories, covering a total area of 118,687 square miles, or 75,959,680 acres. These surveys have covered not only a wide range of soil and climatic conditions, but also the typical soils upon which the chief staple crops as well as many new and special crops are being produced.

THE PROBLEMS ENCOUNTERED.

The work of the soil survey in 1906 and in preceding years, while dealing chiefly with the characteristic soils upon which the staple crops—corn, wheat, cotton, grass, etc.—are produced in different sections and under different conditions of soil and climate, has also encountered many specific problems of wide interest and application. The opening of large areas for agricultural occupation has necessitated in several States a study of the existing soil types in order that the appropriate crops for production upon each might be determined. The widespread interest in the agricultural capabilities of undrained lands in many sections has led to demands for surveys which shall determine the character of crops to which such soils may be farmed after reclamation. The breaking up of large dry-farmed ranches for more intensive forms of agriculture under irrigation has also necessitated surveys which could be used as a basal guide in crop selection. The extension of crops like tobacco and alfalfa into entirely new areas whose soil adaptations were formerly unknown has been made possible by the soil surveys. The introduction of new crops has been accomplished along the lines suggested by the surveys. One of the chief purposes and uses of the surveys has been to aid individual farmers in the selection of land suited to general or special crops in regions unknown or but partly known.

THE SOIL RESOURCES OF THE COUNTRY.

In the work of the soil survey, since its inception in 1899, 461 distinct types of soils have been encountered. Some of these types are of great extent, covering areas measured by thousands of square miles. Still others are of local extent and distribution. Some are distributed over a considerable range of climatic environment. Others are so restricted that they may be said to lie in a single climatic belt. The great striking fact, however, is that with such a great variety of individual soils only about a dozen important crops are now produced in the entire country. Again, the same crop is produced with the greatest diversity of success or failure upon a great variety of soils, to some of which the crop is well suited while upon others it is annually produced at a loss. Before the farmers of all sections of the United States can reduce agriculture to a basis of permanent business success the knowledge of these facts must be thoroly disseminated and fully understood.

It has been found that in addition to the broad subdivision of the country into a humid region, an arid region, and a rather indefinite semiarid region, there are at least thirteen grand divisions among the soils which may be termed soil provinces. The soils of the Atlantic and Gulf Coastal Plains differ materially from those of the Piedmont Plateau. The soils of the glaciated region of the Northern States are

materially different from those of the limestone valleys, and from the alluvial bottom lands or the residual prairies of the Western States. Still greater differences exist between the soils of the Pacific coast valleys or the Great Interior Basin and those of the Eastern State provinces. All of these differences have their deep significance in the selection of crops and in the management of the soils. Even within single provinces there are groups of soils which differ profoundly from all others, and these differences must be recognized and their crop signification understood. Each series also ranges from the coarsest sandy and gravelly types or individuals to the finest-grained clays. No two of the numerous individual soils possess exactly the same characteristics, and no two are, therefore, adapted in the same degree to exactly the same crops nor to the same treatment and handling.

When all of these differences have been ascertained, and when the significance of these differences comes to be understood, the country will be able by the introduction of new crops and by greater specialization in crop production to increase greatly the agricultural efficiency of every tilled acre.

DEMANDS FOR THE WORK.

Each year brings an increasing number of requests for survey work in particular localities to serve a great diversity of interests. The development of new lands in the United States has not ceased and the need for specific and unprejudiced information concerning soils in newly developed regions has become widely recognized. The extension of tobacco culture thru certain portions of the Gulf States has led to numerous requests for surveys to locate areas of soil where the Cuban type of filler tobacco may be grown successfully. Only a few soils are suited to the production of this leaf, and unless such soils are found in an area the attempt to introduce the crop must result in failure. The growth of the fruit interests in all sections of the country has led to widespread demands for surveys to determine what soils are peculiarly adapted to the growing of apples, pears, peaches, grapes, or citrus fruits, the location of these soils, and their extent. The depression of farm values in some sections has called attention to the possibility of rehabilitating these farms and soils thru the introduction of new crops and of new methods, and surveys are requested to furnish guidance along these lines. New areas for the production of market-garden and truck crops are being developed along the Atlantic and Gulf coast lines, and surveys have been requested for many of these areas. The northward spread of the culture of rice upon prairie lands has given rise to requests for surveys to indicate soils and regions where this crop might be introduced.

As a result the Bureau of Soils has always on file requests for several times as many surveys as can be made during any one year, and the completion of each year's work is accompanied by an increased rather than a diminished volume of requests. While such a condition is gratifying from the standpoint of public appreciation of the value of the work, it is embarrassing and unsatisfactory because of the necessity for selecting among so many requests of almost equal urgency those areas which may be undertaken each year. The public demand for the making of these surveys and the constant application for survey reports, not only for areas which have been surveyed, but also for those which have not yet been undertaken, both evince the necessity for a considerable increase in the volume of soil-survey work in the immediate future.

RECLAMATION OF ALKALI LANDS.

The progress of the work on the several alkali reclamation tracts during the fiscal year just closed has been gratifying, both as regards the immediate success of the experiments and as regards the stimulating effect that these results have had upon private initiative in the work of reclaiming similarly affected neighboring lands.

PROGRESS ON THE UTAH TRACT.

On the Swan tract, near Salt Lake City, Utah, the work consisted largely of experiments with various crops, as the removal of alkali had practically been accomplished by repeated flooding in 1903 and 1904. The thrifty growth of alfalfa and of other crops, not perhaps as sensitive to alkali, clearly demonstrates the great changes that have taken place in the soil since it has been treated. Formerly this field presented a desolate appearance, with large areas heavily incrusted with alkali. The success of this experiment can not but be far-reaching in its influence upon the alkali question in the Salt Lake Valley.

COMPLETION OF WORK AT FRESNO.

Our earlier work on the Toft-Hansen tract, near Fresno, Cal., had freed the upper layers of soil from alkali, and very satisfactory crops had been grown; however, while the alkali question had been solved, a constant source of danger was the high ground water, which rises very rapidly in this district after water is turned into the canals each spring. The original drainage system was not very deep, and the question of keeping the drains free from sand and silt proved serious. In order further to experiment with the lowering of the ground water, it was thought advisable to install a new drainage system. This was completed in November, 1905. The entire drainage system was lowered from 1½ to 2½ feet, and the ground water is now kept at a safe depth, not only under the land drained, but under adjoining farms to the extent of 200 acres.

The success of this work has proved of great value to the farmers of the alkali and seepage-infested district about Fresno, and many have signified their intention of undertaking work similar to that carried on by the Bureau of Soils. At the close of the irrigation season of 1906, the Bureau's work in the Fresno district will close, as the owners of the land are well pleased with the reclaimed condition of the soil and the success of the newly installed drainage system.

CONTINUATION OF THE WORK AT YAKIMA, WASH.

In Washington, in the Yakima Valley, the results have not been quite as satisfactory as was hoped when the work was commenced. While parts of the Gervais tract, near North Yakima, have been thoroly reclaimed and produced in 1905 a heavy crop of hay, valued at $160, other parts of the tract have not yielded to treatment so readily. That some parts of the tract still contain appreciable quantities of black alkali is evident from the crop returns, from repeated chemical tests, and from the characteristic dark stains in the soil. It is somewhat difficult to explain the retention of alkali by the soils of the Yakima Valley. It is well known that hardpan retards the movement of alkali, and it seems probable also that the volcanic ash soils of this valley may have a high absorptive capacity, enabling them still to retain injurious quantities of black alkali in spite of repeated flooding.

Good lands in this region produce such profitable crops that the exact treatment for the alkali lands should be ascertained if possible, even tho the total cost of reclamation be great as compared with other districts.

RAPID COMPLETION OF THE RECLAMATION WORK IN ARIZONA.

The record of the Cummings tract, near Tempe, in the Salt River Valley, Arizona, is excellent. The drainage system was installed early in 1904, but no water was available for leaching out the alkali until many months later. When the water supply became more abundant the removal of the alkali was comparatively simple. At the present time 14½ acres support a fine stand of alfalfa, planted in November, 1905, while the remainder has produced a heavy crop of barley. The owner of the land is fully satisfied with the showing of the crops and only awaits the seeding of the small tract to alfalfa before accepting the land according to the contract originally agreed upon. As the water supply of the valley is still further increased by the extensive operations of the United States Reclamation Service in constructing storage reservoirs, the subject of eliminating alkali and controlling the ground water will become more important, and the Bureau is very fortunate in having undertaken and completed this work at such an opportune time.

RESULTS IN MONTANA.

The showing of the O'Donnell tract in the Yellowstone Valley, Montana, is fully as good, if not better, than the one just mentioned. The drainage system was installed during 1904, but too late to allow any flooding. During 1905 the land was continuously flooded for several months. From the outset the drainage system worked perfectly and large quantities of alkali were removed by the drainage water. Tests made in June, 1906, showed that the alkali content to a depth of 4 feet had decreased to approximately 0.2 per cent over the entire tract. In 1904 the soil contained more than 1 per cent to a depth of 4 feet, largely concentrated in the first and second feet. The comparison shows the extent to which the alkali had been removed by a single year's flooding. Early this year the soil was put in order and seeded to oats. This crop produced a yield that compared favorably with the most productive lands in the valley.

Since it has been shown that alkali can be removed from the soils in the Billings district the outlook is most promising. One of the worst alkali and seepage areas has been included in a drainage district, and a deep outlet ditch now constructed will serve to carry the surplus water from smaller, more detailed drainage systems in individual fields. Smaller local drainage systems are also being formed by private enterprise.

NEED FOR CONTINUING THE DEMONSTRATIONS.

In carrying on the work in reclaiming alkali soils we have had many different conditions to meet and local difficulties to overcome. At each tract the character of the soil differed from that of the other tracts, and at no two places are the alkali conditions nor the details of attacking the problem the same. This makes plain the wisdom of extending the work to other affected districts in order that full and exact plans may be placed in the hands of the farmers suffering this common evil of the arid West.

Already urgent requests for the extension of this work are on file in the Department, and in view of its great economic importance it is the intention to follow the completion of the present demonstrations with the reclamation of small tracts in some other of the worst affected sections. There is no one soil problem more important to a large number of our western farmers than this, and none, happily, that is capable of such quick solution or that involves so great and so certain immediate increase in their wealth.

TOBACCO INVESTIGATIONS.

During the fiscal year just closed the Bureau of Soils has continued its investigations for the improvement of tobacco in Texas, Alabama, Ohio, Virginia, and Connecticut.

EXPERIMENTS IN TEXAS.

The tobacco grown in Texas during the preceding year was distributed to the trade for the purpose of ascertaining its commercial value. In all 300 samples were sent out, and from the numerous replies received it can be positively stated that the tobacco produced in Texas meets the requirements of the trade as a high-class domestic filler. About 200 acres are now being grown on the Orangeburg soils in Nacogdoches, Anderson, Houston, and Montgomery counties in east Texas, while in central Texas, in Lavaca and Lee counties, experiments were conducted on similar soils. The industry is now assuming a commercial status, as a ready market has been created for the leaf. Great interest has been shown by the trade, by railroads, and by local interests in east Texas as a tobacco-producing region, and, with the promising beginning made in the counties mentioned, there is every reason to believe that this section of the State will soon be recognized as an important factor in our tobacco industry.

PROSPECTS IN ALABAMA.

The investigations for the production of filler leaf in Alabama have this past year been extended into Dallas County, in the southern part of which the Orangeburg soils appear. In Perry County the acreage increased over 100 per cent. A ready market has been found for the product, and this has proved a stimulus to the growers. The tobacco produced is similar in quality to the Texas and Florida leaf, and the cost of production is a little less.

FERMENTATION AND SELECTION IN OHIO.

In Ohio the work of introducing the bulk method of fermentation has been continued, and over 25,000,000 pounds of tobacco have been fermented according to the method prescribed by the Bureau of Soils. It has taken a period of five years to accomplish these results, and the system is now so well established in Ohio that the packers should be able to proceed without further supervision by our experts. Besides the fermentation work, the work of introducing Cuban seed filler in Ohio has been continued, 25 acres having been planted by the farmers under the direction of the Bureau. This was contracted for with local packers at prices ranging from 18 to 20 cents a pound.

In Ohio, also, cooperative experiments have been conducted with the Bureau of Plant Industry in the selecting and breeding of improved types of tobacco, with a view to securing types of leaf giving a larger

yield and having a uniform quality. Selections were made of Zimmer Spanish, Little Dutch, Ohio Seedleaf, and Ohio Cuban. It is believed that by this method of selection of seed native varieties of Ohio tobacco may be greatly improved, since where so many varieties are grown, as in the Miami Valley of Ohio, there is great danger of their becoming mixt.

EXPORT TOBACCO IN VIRGINIA.

The experiments begun in Virginia in 1904 with heavy fire-cured tobacco have been continued during the past fiscal year. In the first year of this work it was demonstrated that by the use of carefully selected fertilizers the profits in growing this type of leaf could be increased considerably as compared with those obtained by the Virginia farmer. During the past year the same treatment of the same land was followed, and, between the two crops of tobacco, rye was sown as a cover crop and plowed under in the spring of the year. The results obtained show the accumulative effects of the fertilizer and cultural methods used. The land was divided into 3-acre plats. On one the fertilizer practise common to the locality was followed, on the second a slightly better brand was applied, and on the third a still more expensive application was made.

The cost of production of the three plats was respectively $44.50, $63.60, and $85.49, which shows a net profit of $15.63 on plat 1, $37.01 on plat 2, and $40.10 on plat 3. It is interesting to note that the same plats of ground receiving the same treatment in 1904 netted profits of $5, $21, and $24, respectively, showing gains in 1905 over 1904 of $10.62, $16.01, and $16.10, respectively. These results are highly significant as indicating what may be done in this important tobacco district by the use of such methods as are practised, for instance, by the Connecticut Broadleaf growers.

BEGINNING OF EXPERIMENTS WITH VIRGINIA BRIGHT TOBACCO.

Investigations for the improvement of the Bright tobacco of Virginia were also begun during the past fiscal year (ended June 30, 1906), in cooperation with the Virginia Experiment Station, the experimental field being situated near Chatham, in Pittsylvania County, the center of the Bright tobacco belt of Virginia, and within 20 miles of Danville, the largest market for this class of tobacco. The experiment is still in progress, and it will be impossible to report definite results until next year.

CONNECTICUT SHADE-GROWN TOBACCO.

In the Connecticut Valley the work of producing, under shade, a wrapper leaf having all the qualities demanded by the trade has been continued in connection with the breeding experiments of the Bureau of Plant Industry. Eleven selections were taken in a 4-acre tent, seven from Sumatra seed and four from Cuban seed of the third generation in Connecticut. The yield of Sumatra ranged from 1,445 to 1,612 pounds per acre, and of Cuban from 1,134 to 1,384 pounds per acre. Out of these eleven types there have been selected two types of Sumatra and one of Cuban seed that appear to meet the demands of the trade.

Besides the area in the experimental tent of the Department, there were grown by private planters during the year about 120 acres under cloth shade, both Cuban seed and Connecticut Broadleaf being planted.

This is a slight increase over the acreage planted the preceding year and indicates that the trade is becoming interested in the shade product. One firm growing Broadleaf sold the tobacco for $1,061 an acre, giving a profit of about $300 an acre. The Cuban tobacco was sold for $1,200 an acre. During the summer of 1906 the crop grown by the Department from selected seed of both the Cuban and Sumatra varieties was distributed to thirty-three of the largest leaf dealers and cigar manufacturers in the principal cities of the East. These were sent out with a request that they test the leaf and report to the Department their opinion of its quality and its adaptability for manufacturing purposes. Up to the time of closing this report answers have been received from twenty-five of those to whom samples were sent, and with one exception they report that the tobacco has all the qualities demanded by the trade in a domestic cigar wrapper, and if tobacco similar to the samples sent can be grown on a commercial scale they do not hesitate to say that a ready market can be found for it.

There can be no question that tobacco of this quality can be produced on a commercial scale by careful growers if the methods used and recommended by the Bureau of Soils are followed. Notwithstanding the uniformly favorable reports received from the trade on the merits of this tobacco, the Bureau, however, would caution the prospective grower against embarking in the industry on too large a scale at the outset.

PREVENTION OF POLE SWEAT.

Owing to the serious damage caused annually in Connecticut by pole sweat or house burn, the Bureau of Soils conducted some preliminary investigations in curing sheds containing both the cut and primed tobacco. A detailed record of the moisture and temperature conditions in each shed was kept, as also of the condition of the tobacco, with a view to determining the point of relative humidity and temperature of atmosphere at which tobacco would begin to pole sweat and the means to prevent the atmosphere of the shed becoming such as to favor its spread. This study will be closely followed, as it is believed that results can be obtained which will be of great value to the Connecticut growers.

Urgent demands have been made upon the Department to extend its operations into Florida, Maryland, Wisconsin, and Tennessee, but owing to the limited appropriation for this work it has so far been impossible to comply with these requests.

BUREAU OF ENTOMOLOGY

Practically all of the investigations under way in the Bureau of Entomology at the time of my last report have been continued with excellent results, and several new and important lines of work have been begun.

THE MEXICAN COTTON BOLL WEEVIL.

Encouraging progress has been made in the work against the Mexican cotton boll weevil, as shown by an extensive canvass of the cotton planters who have followed the recommendations of the Bureau.

Owing to climatic conditions in the summer and fall of 1904 and in the winter of 1904–5, some of the area that became infested late in the summer of 1904 was entirely devoid of weevils in the early part of 1905, but the fall movements of the weevil in 1905 more than covered

this area. This permitted studies for which there had been previously little opportunity, and many points which had a bearing upon the possibility of the continued advance of the pest were investigated.

EXPERIMENTAL FARMS.

The continuation of the experimental farms at fourteen places in Texas has been deemed desirable, as the value of experimental field work depends largely upon the number of seasons thru which it has been carried. Two additional experimental farms have been carried on in Louisiana. The whole acreage placed under contract in these experiments is 877.

The modifications in the cultural system of lessening damage, made necessary by the change in habits of the insect, were carefully studied in connection with the work carried on in the laboratory.

OTHER FIELD WORK.

In addition to experimental plats on a large scale numerous field experiments were conducted, including an extensive experiment in the hand picking of infested bolls and considerable other work directed to the solution of questions which can not be tested with the fullest practical effect in the laboratory.

The continued spread of the weevil has been carefully watched, and publications regarding the new territory infested have been issued in cooperation with the Weather Bureau. Careful study has been made of the conditions in western Texas in order to determine whether the weevil is likely to spread to that part of the State in spite of the general idea that such spread will not take place.

LABORATORY WORK.

In the well-fitted laboratory now located at Dallas, Tex., the effects of different temperatures and the condition of food supply upon the development of the weevil were tested, the breeding of parasites was continued, and a special study was made of a native ant which seems to be becoming more and more an important factor in the natural control of the weevil. Investigations of the distribution of this ant, its adaptability to different soil conditions, and the possibility of its artificial propagation have also been made.

TRUE PARASITES OF THE BOLL WEEVIL.

Since the weevil entered Texas native parasites have had little effect upon it until recently. During the year, however, it was found that in the Brownsville region—first entered by the weevil about 1893—native parasites have accommodated themselves to its habits, and now at least 50 per cent of the early stages are sometimes destroyed by these parasites. Consequently much attention is being paid to the parasite question, in order to determine whether it will be possible to assist the work of these beneficial insects. It seems probable that the small results gained from the work of parasites down to the present time are largely due to the recent invasion of the cotton fields of the South by the injurious insect.

COOPERATION WITH THE LOUISIANA CROP PEST COMMISSION.

Cooperation with the Louisiana Crop Pest Commission, begun in 1904, was continued during the year, three assistants being employed by the Bureau for work in Louisiana. During the season of 1905 it

was planned to enter upon an extensive study of the so-called migratory movement of the boll weevil in order to learn, if possible, some method of checking its further advances, or at least to learn more definitely the approximate time when other regions may become infested. On account, however, of the occurrence of yellow fever and the consequent rigid quarantine, it was impossible to carry on this work in full, but a number of important observations were made. In cooperation with the commission more than 25,000 weevils were carefully studied under natural conditions during the winter.

THE COTTON BOLLWORM.

The work on the cotton bollworm during the fiscal year was largely in the character of demonstrations, indicating the value of conclusions already reached and detailed in the last annual report of the Entomologist, and successful efforts were made locally in the extermination of the bollworm by means of poisons.

OTHER COTTON INSECTS.

The work on other cotton insects has been done largely in cooperation with the Texas Agricultural Experiment Station. A field agent of the Bureau was stationed at the Texas Agricultural College, devoting his attention to the other insects affecting the cotton plant. The important discovery has been made that it is possible to propagate the predaceous enemies of the cotton plant-louse, an insect which sometimes causes great damage to young cotton. It is believed that this work will lead to a practical method of controlling the pest.

INTRODUCTION OF BENEFICIAL INSECTS.

The most important work in connection with the introduction of beneficial insects has been the importing from Europe of the parasites and predaceous enemies of the gipsy and brown-tail moths, in cooperation with the officials of the State of Massachusetts.

PARASITES OF THE GIPSY MOTH AND BROWN-TAIL MOTH.

It has been shown that it is an easy matter to bring the European parasites of these injurious insects to this country, simply by collecting numbers of the larvæ and chrysalides in different parts of Europe and sending them direct to Boston. A certain percentage of these insects on arrival in New England have given out the European parasites, which have either been cultivated in wire-gauze inclosures, with plenty of food, or have been liberated in the open, there being chosen for this purpose patches of woods not subject to forest fires or to remedial work against the insects. It has been ascertained further—and this is a fact hitherto unknown even to European entomologists—that the young larvæ of the brown-tail moth in their overwintering nests in Europe are extensively parasitized. Therefore, during the winter of 1905–6 over 117,000 nests of the brown-tail moth were collected in 33 different localities in Europe, ranging between North Germany, South Hungary, and West Brittany, and comprizing a large range of varying elevations and climatic conditions. More than 70,000 parasites were reared from these nests on American soil. About 8 per cent of these were hyperparasites; that is, parasites upon parasites.

By means of specially constructed cages the hyperparasites were separated and destroyed. The primary parasites were placed in out-of-door cages or liberated in the open. The largest colonies included 10,000, 15,000, and 25,000 parasites, respectively. Owing to the very wet season a fungous disease prevailed among the caterpillars, vitiating to some extent the results of the experiments, but nevertheless three species of parasites were seen to lay their eggs in American-born caterpillars, and there is positive proof of the development on American soil of at least one complete generation of two of the European species. It has been shown that they may breed successfully thru the season.

Egg parasites of the brown-tail moth have also been imported during the summer, and have been seen to lay their eggs in the eggs of North American injurious insects. Two important European predatory ground beetles have been successfully imported, and have bred thru an entire generation upon American soil. Large numbers of Tachina flies have been reared from European specimens of the larvæ of both the gipsy moth and the brown-tail moth, and are breeding in the vicinity of Boston.

The greatest care has been taken to prevent the introduction of hyperparasites and other injurious insects, and there seems every reason to suppose that sooner or later the complete natural environment of both the gipsy moth and the brown-tail moth will be established in New England, placing them on a par with European conditions, thus greatly reducing their present importance.

NEW LADYBIRDS FROM EUROPE.

During the late winter months and spring of 1906 several species of European ladybirds, well known as destroyers of plant lice, scale insects, and soft-bodied insects of other groups, have been imported from Germany, France, and Austria. All of these have been liberated in the vicinity of the parasite laboratory at North Saugus, Mass., the country about being orchards and forests, with an occasional vegetable garden, promising plenty of food for the beneficial species.

THE KELEP OR GUATEMALAN ANT.

Efforts to successfully overwinter in Texas the kelep or Guatemalan ant enemy of the cotton boll wevil have failed and a possible useful rôle for this insect in Texas is seemingly very slight. It is possible that this species may have some economic value in some of our tropical or subtropical possessions, where the climate will be more suitable than in Texas.

THE SENDING OF USEFUL INSECTS ABROAD.

It is possible, in many instances, to secure the sending of beneficial insects by the official entomologists of other countries without expense to the Department, as was done notably in the case of the introduction of an important enemy of the black scale from the government of Cape Colony, South Africa. In return for such services and as an earnest for possible future courtesy of the same sort exportations of parasitic and predatory insects have been made, under the auspices of the Bureau of Entomology, to foreign countries. A notable instance has taken place during the fiscal year. A scale insect which occurs

abundantly upon various fruit trees in portions of the United States is a serious enemy to the mulberry tree in Italy, and therefore large sendings of parasitized scales of this species have been shipped to Professor Berlese, Director of the Royal Station for Agriculture and Entomology, at Florence. After arrival two species of parasites were bred in some numbers, and efforts are now being made to colonize them in Lombardy. It is hoped that they will prove effective aids in the eradication of the mulberry scale.

INSECTS DAMAGING FORESTS.

Investigations of insects damaging forests have progressed in a satisfactory manner in cooperation with the Forest Service of the Department. Numerous problems have been studied and a large store of general information upon forest insects has been accumulated.

Field work has been conducted from stations in West Virginia, North Carolina, South Dakota, Idaho, Washington, and California, the locations of the stations being determined by the advantages offered at the points selected for the study of some special problem or problems.

A special investigation was carried on in regard to the Black Hills beetle, which has extensively ravaged the forests in Colorado, and the results prove to be in the highest degree satisfactory and have been published in Bulletin 56 of the Bureau. The recommendations are now being actively followed by private persons with excellent chances of checking what might otherwise prove a most serious invasion.

The conditions in the Black Hills are not so encouraging, owing, doubtless, to the failure of the parties interested to realize the importance of the recommendations of the Bureau. These difficulties, however, have now been partially overcome, and all concerned seem alive to the seriousness of the situation.

Investigations in the South of the destructive pine-bark beetle and of a number of important insects injurious to forest products have been carried on, and studies have been made in regard to the insect enemies of forest reproduction. Special studies and recommendations have been made concerning the western pine-bark beetle in the region north of Boise, Idaho, and a study of the forest insects of the Pacific slope has been carried on.

INSECTS DAMAGING DECIDUOUS FRUIT TREES.

For the investigation of insect enemies of deciduous fruit trees field stations at Youngstown, N. Y., and Fort Valley, Ga., were carried on to the close of the growing season of 1905, and in the spring of 1906 others were started at Myrtle, Ga., and North East, Pa. Later another one was established at Nebraska City, Nebr. In the course of this work some studies have been made of the parasites of the San Jose scale, and experiments have been made with a number of insecticide mixtures. The chemical study of the lime-sulfur and other washes has been undertaken in cooperation with the Bureau of Chemistry. New studies have been made of the plum curculio. The peach borer has also been studied thruout its geographic range, and extensive demonstration work has been done in Nebraska on remedies for the codling moth, in cooperation with the Bureau of Plant Industry, which at the same time was dealing with the apple scab, combination

treatments for both being carried on cooperatively. Cooperation in this work is also under way with the several other experiment stations and the Georgia State entomologist.

FIELD-CROP INSECTS.

The most important work in connection with field-crop insects has been upon the Hessian fly and jointworms, especial investigations having been made of the Hessian fly in the spring-wheat regions. It was predicted that this insect would not damage wheat in regions where the spring crop is exclusively grown. This has proved to be a fallacy, and by reason of remarkable changes in the life history of the insect it has adapted itself to the conditions existing in the far northwestern country. This means a radical modification in remedial work, and the studies have indicated that it will not be difficult to bring about conditions of comparatively small insect damage. Important results have also been reached in the study of parasites of the Hessian fly, which will probably have a marked effect upon the multiplication of the fly. In the same way the jointworm investigations have resulted in the acquisition of important knowledge, both regarding possible remedial work and the handling of parasites. Studies have also been made of clover seed and clover insects, and also of other field-crop pests.

INSECTS AFFECTING VEGETABLE CROPS AND STORED PRODUCTS.

Work on insects affecting vegetable crops and stored products has been continued along the same lines as conducted in previous years. Insects affecting the sugar beet have been studied with care, and a special investigation has been made of a leaf hopper affecting this crop in Utah, Idaho, and Colorado. Many other insects of this group have been under careful observation, and results of value have been obtained.

INSECTS WHICH CARRY DISEASE TO MAN AND DOMESTIC ANIMALS.

The work of the Bureau on the subject of mosquitoes has been continued. A further study of the yellow-fever mosquito was made in the autum of 1905, and experiments were made with remedies and methods of destruction against both larvæ and adults. Records have been brought together of the life histories and geographic distribution of the majority of the mosquitoes inhabiting North and Central America and the West Indies.

In the spring of 1906 a publication was issued upon the subject of the house fly, calling attention to its agency in the spread of typhoid fever, pointing out proper methods for its control, and urging the adoption of these methods by individuals and communities.

It was shown by observations made by the Bureau of Entomology upon a series of stables in two different sections of the city of Washington that it is a comparatively easy matter greatly to reduce the numbers of the house fly in any given community at a comparatively slight expenditure of funds and effort.

The investigation of the life history of the Texas cattle tick, mentioned in the last annual report, has been continued in cooperation with the entomologists of the States of Louisiana, Arkansas, Alabama,

Tennessee, and South Carolina. This work has considerably increased our knowledge of the development of the tick, and in connection with this work the life history and habits of a number of other common ticks, frequently confused with the fever-transmitting species, have been investigated.

SCALE INSECTS AND EXPERIMENTAL WORK WITH INSECTICIDES.

This work, in special charge of the Assistant Chief of the Bureau of Entomology, has been continued. An immense amount of material in this group is sent in to the Bureau for identification and advice and the work grows in importance and value.

A thoro inspection was made of all new plants which the Department of Agriculture is importing from different parts of the world to detect and destroy any new insect enemies, principally scale insects, which might be brought in with them.

The work with insecticides has covered tests with standard insecticides, fumigation of mills, granaries, and dwellings against insect pests, and many new insecticide ideas or mixtures, which come to the Bureau for attention almost daily, have been examined and reported on.

Tests carried on upon a large scale and in a very thoro manner with sulfurous-acid gas have fully demonstrated its usefulness.

BEE CULTURE.

The work on bee culture has greatly increased. A large number of queen bees of different varieties were reared and distributed from the Department apiary, as well as from the substation at Chico, Cal. Investigations of the giant bees of India and the Philippines were continued thru the year.

The various methods of queen rearing have been tested in rearing queens for distribution, and studies in bee diseases and in the important subject of honey-producing plants have been carried on.

SILK CULTURE.

There has been no change in the method and scope of the work on silk culture during the year. The correspondence was increased; a supply of eggs has been brought from Europe and distributed to correspondents in the United States; mulberry stock has been distributed, and cocoons have been purchased from correspondents and reeled.

OTHER INVESTIGATIONS.

Work on insects injurious to strawberry, raspberry, blackberry, and other bush fruits has been continued, and studies have been made of insects injurious to flower gardens and in greenhouses. An especial study of the insect enemies of roses is under way. The study of insects affecting shade and ornamental trees has also been continued, and an investigation has been made into the habits of the gad flies.

Routine work in the laboratory has greatly increased and biological studies have been made of nearly 500 species not hitherto studied. Increase has also been noted in the work of determining specimens for the entomologists of experiment stations and other workers. Many thousands of specimens have been received for this purpose.

BUREAU OF BIOLOGICAL SURVEY.

GEOGRAPHIC DISTRIBUTION.

LIFE AND CROP ZONES.

The Biological Survey deals with many of the problems of the farm, orchard, and stock range, and aims to answer in a practical way many of the questions that arise in their management. One of the most important of these is the selection of crops and breeds of stock adapted to the local peculiarities of temperature, moisture, and other climatic factors that prevail, not only in different areas, but which in mountainous regions often characterize different parts of the same farm. A direct and reliable guide to such selection, apart from costly experimentation, is afforded by the distribution of the native plants and animals, for it has been learned that animals and plants are not scattered haphazard over the land, but in their distribution are governed by fixt laws. Thus the association, on a given area of certain birds, mammals, trees, and shrubs, presupposes the existence there of certain climatic and physical conditions.

It naturally follows that there is a direct relation between the plant and animal life of such an area and the nature of the crops that can be grown upon it. The purpose of a biological survey of the several States is to supply life-zone maps based upon a study of the natural animal and plant life, followed by crop-zone maps with lists of fruits and crops which will best thrive in such areas. A generalized report of this nature, covering the United States as a whole, has been already published (Bull. 10, Biological Survey). The work is now being carried on in more detail and on larger scale maps in several of the Western States.

DISTRIBUTION AND MIGRATION OF DUCKS AND SHORE BIRDS.

As the game birds of the country diminish in numbers, and as their importance in the eyes of sportsmen and for food increases, the necessity of legislative protection becomes more imperative.

In order to afford an accurate basis for such legislation, the routes of migration and the time of arrival and departure of ducks and geese and the shore birds have been carefully studied.

ECONOMIC INVESTIGATIONS.

ECONOMIC MAMMALOGY.

The field included in this branch of the work is wide and important, the losses inflicted upon the agricultural and stock-raising interests in the United States by noxious animals amounting annually to many millions of dollars. The most prominent offenders are the wolves and the gnawing animals known as rodents—especially the rats and mice, rabbits, ground squirrels, and gophers. Much time and ingenuity and vast sums of money have been expended in devising means to restrict the numbers and minimize the damage done by these animals. Traps, poisons, and gases have been carefully experimented with under varying circumstances, and have proved more or less effective, but the farmer does not always possess the requisite time and skill to employ them to best advantage, and even when they serve to accomplish the object intended the cost is considerable.

Meanwhile agriculture is assuming more and more importance in the United States, and with increasing crops comes a corresponding increase in the numbers of the pests that destroy them.

In the hope of finding a remedy, the Bureau of Biological Survey is now engaged in experiments with epidemic diseases—diseases which in the course of nature break out at intervals and serve to reduce the numbers of rabbits, squirrels, mice, and other noxious animals to below the danger point. As some, if not all these diseases, are of bacterial origin, it is thought possible to obtain and preserve cultures of them for employment when and where occasion arises. Prior to their use in the field, however, a series of careful experiments is necessary to determine the character of the diseases—whether limited, as some undoubtedly are, to particular animals—the degree of their virulence, the extent of their communicability from animal to animal of a colony, and above all to make sure that human beings and farm stock are immune from their influence.

In cooperation with the Bureau of Animal Industry, experiments have been already made with a virus for destroying rats and mice, and in cooperation with the State Agricultural Experiment Station at Pullman, Wash., experiments are being tried with a disease endemic to one of the ground squirrels of that region. The results of the latter experiment are awaited with peculiar interest, since the area infested by ground squirrels in Washington, Oregon, and Idaho is very large, and everywhere over it great damage is done to the wheat crop.

With a view to eliciting timely information as to the prevalence of epidemic disease among rabbits, ground squirrels, prairie dogs, rats, and mice, a circular of inquiry has been widely distributed. The subject is one of large possibilities, and time and money will be well spent if effective and economical methods are found to relieve the farmer of part of the burden and expense of protecting his crops from rodent pests, which are as numerous and destructive as they are ubiquitous and elusive.

DEPREDATIONS BY WOLVES.

In cooperation with the Forest Service investigations are being made with a view to the reduction of the numbers of wolves on the stock ranges and on the game and forest reserves of the West. Wolves are still numerous in certain sections, and by reason of their size and strength constitute a formidable enemy to stock and to wild game. It is thought that effective means for the abatement of the nuisance have been found and a report on the subject will soon be ready for publication.

THE RABBIT PEST.

The damage to nurseries, orchards, and crops of the United States by rabbits has always been great, tho happily nowhere reaching the proportions reported in Australia. Many experiments have been made by assistants of the Survey for the purpose of discovering cheap methods of protecting orchards by wire fencing and by other means, and of reducing the number of rabbits by traps and poisons. It is believed that young trees in orchards and in forest reserves, where they are particularly liable to destruction by rabbits, can be cheaply and efficiently protected by cylinders of woven wire, and experiments are being undertaken in cooperation with the Forest Service for testing the efficiency of such protectors. Rabbits in various parts of the country appear to be peculiarly susceptible to epidemic diseases, and as they are one of our most destructive rodents special efforts are being made to detect the presence of one of these epidemics for the purpose of securing cultures as a means of reducing their numbers.

THE BOLL WEEVIL.

During the year investigations were continued in the Texas cotton districts with reference to birds that feed upon the weevil. The results are encouraging. In all, 28 species of birds have been found to be more or less active enemies of the insect. Included in this number is the nighthawk, heretofore not known to eat the weevil. The nighthawk proves to be an active consumer of the insect. Its protection by law therefore is earnestly recommended. This is all the more necessary, since the bird is often shot for food.

Of all the birds that prey upon the weevil, orioles are the most active and persistent. For this reason the possible introduction into the Gulf States of one or more additional species of these birds is being considered. Only one of the three species that visit the cotton-producing belt breeds extensively within it; hence if one is introduced it should be a species likely to make its summer home within the area infested by the weevil, as all birds are particularly assiduous in their search for insects during the time they are feeding the young.

CALIFORNIA FRUIT ORCHARDS.

Work in the California fruit orchards is being continued and a study made of the food habits of birds destructive to orchard fruit, with a view to the suggestion of preventive measures.

Careful investigations are being conducted also into the food habits of all birds that live in and around orchards, so that the orchardist may be clearly informed as to the beneficial species, in order that he may be able to discriminate between friends and foes.

SCALE INSECTS.

Few kinds of insects are so inimical to the health and existence of fruit trees and other crop plants as the scales, and owing to their small size and peculiar habits few are so difficult to cope with. It has been generally supposed that birds lend no assistance in the destruction of scales. This proves to be an error, for the Biological Survey has already found that more than 50 species of birds eat scale insects. Not only is this true, but in the case of certain species, as the grosbeaks, scales have been ascertained to form a large percentage of the food.

GAME PROTECTION AND INTRODUCTION.

The experience of many countries proves how widespread is the desire to introduce foreign mammals and birds. When these are merely for cage pets or for exhibition in zoological collections, little or no harm results. But when, as frequently happens, exotic species are liberated in the hope that they will become acclimated and form permanent additions to the fauna, there is always danger that, like the English sparrow, they will be only too successful in adapting themselves to the new environment and prove serious pests. The disastrous experiments of Jamaica, Porto Rico, Hawaii, New Zealand, Australia, and other regions abundantly illustrate this danger. Several countries take the precaution of regulating such importations, the United States among the number. Since 1900 the Department of Agriculture has supervised all importations of live birds and mammals into the United States. A few well-known species of birds and mammals are allowed to enter without special authorization, but all others are refused entry except under permit by the Department. The number thus entered during the year was 654 mammals, 274,914 canaries, and 47,256 miscellaneous birds.

The growth of the trade in imported birds is made manifest by the fact that the figures show an increase of 25 per cent over those for last year, and of 33, 27, and 37 per cent, respectively, over those for 1903–4, 1902–3, and 1901–2. Despite the large number of birds and mammals imported under permit, averaging more than 6,000 a week thruout the past year, it is believed that no prohibited species was brought into the country.

Increased interest is shown in the importation of foreign game birds for stocking covers. During the year 864 European partridges, 116 capercailzie, 73 black game, and 59 other game birds were imported for this purpose. Some of these experiments promise excellent results.

Stocking covers with birds hatched from imported eggs has heretofore been unsuccessful in most cases. Last spring, however, of 5,564 eggs imported under permit by the Department, 5,500 were English pheasant eggs secured by the game commissioner of Illinois, who reports that 3,000 live, healthy chicks were obtained—an unusually large percentage.

Large shipments of birds are examined by inspectors and the number and kinds are reported to the Department. The expense of fees has hitherto been borne by importers, since no appropriation for the purpose was made by Congress. This arrangement proved unsatisfactory and protest was made by importers. Since February 1, 1906, the Department has undertaken to pay these fees, and an appropriation should be made to sustain the service, as in the case of inspection of meats. The lack of such appropriation permits inspection only of the most important shipments.

INTERSTATE COMMERCE IN GAME.

The close surveillance of interstate traffic in game established in the Middle West has driven illegal shippers to the use of freight instead of express, and has brought the situation in that region under partial control. Attention will therefore be centered during the coming year on the Southwest, where systematic violations of the law are frequent. An effort will be made also to check numerous illegal shipments that occur in the South, particularly in West Virginia, Virginia, and North Carolina.

The limited means available for this work make progress slow and difficult. A sufficient sum should be appropriated to permit the employment of three supervisors at Chicago, St. Louis, and Baltimore, respectively, to study conditions, secure evidence of illegalities, assist prosecuting officers, and aid generally in a more effective enforcement of the law.

BIRD RESERVATIONS.

One of the most successful methods of preserving the birds of a country is by setting aside regions that contain important colonies of breeding birds as bird reservations or "refuges." England, Australia, Canada, New Zealand, and other countries have followed this plan with great success, and in 1903 the United States inaugurated it by making a bird reservation of Pelican Island, Florida, to preserve the only colony of brown pelicans on the east coast of Florida. Afterwards two more reservations were established—Breton Island, Louisiana, and Stump Lake, North Dakota—and in the year just ended four more were added to the list, two in Florida, consisting of

Passage and Indian keys, at the mouth of Tampa Bay, and two in Michigan, comprising the Huron Islands and the Siskiwit Islands in Lake Huron.

These reservations contain large colonies of water birds—ducks, gulls, terns, pelicans, etc.—and their establishment will serve to preserve certain native species from possible extermination and provide favorable places for the study of bird life. It has been found essential to have Federal authority to punish trespassers instead of depending on varying State laws, and accordingly, at the suggestion of this Department, Congress past an act (approved June 29, 1906) providing a penalty for trespass on bird and game reservations. This law will enable the wardens on bird reservations to protect them from marauders.

BIG GAME REFUGES.

It is gratifying to state that part of the herd of dwarf elk presented to the Government by Miller and Lux was successfully transferred to the Sequoia National Park in November, 1905, thus insuring the preservation of this rare species.

It is now possible, also, to transfer to an ideal buffalo range in the Wichita game preserve the herd of buffalo offered to the Department by the New York Zoological Society, as Congress at its recent session appropriated $15,000 for the construction of the fence necessary for a proper inclosure.

The plan of preserving big game from extermination by providing game refuges where shooting is either prohibited or carefully regulated is at present attracting attention all over the world. In order to profit by the experience of other countries in a matter that must soon be of pressing interest in the United States, investigation has been made of the systems employed in Canada, particularly Ontario and Quebec, the Transvaal, Natal, British East Africa, Sudan, and Cape Colony. This work has been carried on by correspondence and will be continued and extended during the coming year.

GAME PROTECTION IN ALASKA.

The preservation of the game of Alaska continues to present difficult problems. With the present unsatisfactory game law, and no appropriation available for enforcing its provisions, the efforts of the Department have been confined to preventing export of heads and skins by trophy hunters and dealers in hides, a fruitful source of destruction.

INFORMATION CONCERNING GAME.

In performance of the important duty of collecting and disseminating information relating to game, the annual summary of game laws, posters of close seasons, and directory of officers and organizations concerned in the protection of game have been published as usual, and also various pamphlets relating to special features of game protection. In the near future it is intended to secure and publish information concerning hunting-license statistics, game refuges and preserves, introduction and propagation of game birds, duties of the modern game warden, and the cage-bird traffic of the United States.

The constant demand for information on these and kindred matters shows how important is this phase of the work. It is impossible to meet this demand satisfactorily with the present limited force and available means, and an increase in both is much needed.

DIVISION OF PUBLICATIONS.

The work of the Division of Publications continues inevitably to increase with the growth of the Department. The number of publications issued in 1904 was 972; in 1905, 1,072; and in 1906, 1,171. The number of copies issued in 1906 aggregated 13,488,021. The larger proportion of these publications consisted of reprints, but the new publications in 1906, exclusive of those of the Weather Bureau, numbered 414.

FARMERS' BULLETINS.

The total number of Farmers' Bulletins issued during the fiscal year was 437, of which 404 were reprints, and the total number of copies issued was 6,568,000.

The demand for Farmers' Bulletins by Senators and Representatives, who under the law are entitled to 80 per cent of the whole number printed, has been so much larger than usual that practically none were left to carry over to the present fiscal year. There being therefore no surplus available and the appropriation for the current fiscal year being no larger than formerly, the number available for each Congressman will this year be greatly reduced. I have therefore felt obliged to include provision for an increase in the number of these bulletins in my estimates for the ensuing year. The number of copies of Farmers' Bulletins distributed during the past year on Congressional orders aggregated 5,279,476.

ADVISORY COMMITTEE.

On January 23, 1906, in accordance with your Executive order of the 20th of that month, I appointed an advisory committee on the subject of printing and publication, as follows: The Assistant Secretary, chairman; the Chief of the Weather Bureau, and the Department Editor, secretary. The rules laid down for the guidance of the committee in the Executive order referred to, conform so closely to the regulations governing the printing and binding of this Department imposed upon the Division of Publications, of which the Department Editor is the chief, that it was not found necessary by the committee to adopt a different system of work or to recommend many changes in the existing orders. The services of the committee were, however, extremely helpful in disposing of many questions submitted to it by the Department Editor, which would otherwise have called for my personal intervention. Up to date the committee has held ten meetings, not at stated times, but at the call of the chairman whenever questions of importance were ready to be submitted to it.

CONGRESSIONAL PUBLICATIONS.

Several important amendments to the law governing the public printing and binding have resulted from the special investigation conducted by the Joint Committee on Printing of the Senate and House. One of these provides that the first cost of all publications known as Congressional publications shall be charged to the printing fund of the Department itself instead of to the appropriation for the printing and binding for Congress, together with the cost of the copies assigned to the Secretary for Departmental use. This has made it necessary, of course, to secure an increase in the appropriation for printing for the use of this Department, and the additional amount estimated, as

above made necessary, has been duly appropriated by Congress. This, in reality, is not an increase, but a transfer from one fund to another.

Another amendment provides that public documents ordered printed for Congress may be printed in two or more editions not exceeding in the aggregate the total number authorized by law. This provision applies not only to the number assigned to the use of Congress, but also to the number assigned to the use of the Department. This amendment will doubtless tend greatly to prevent waste by over-publication.

LIMITATION OF APPROPRIATION FOR PRINTING.

A further amendment to the law provides that estimates for the printing and binding of each Department shall be included in a single item, and that after the expiration of the current fiscal year no appropriations other than those made specifically and solely for the printing and binding shall be used for such purposes. In this connection, I desire to place myself on record as strongly favoring the inclusion of the appropriation for printing and binding in the regular appropriation bill for the support of this Department, instead of being, as now, included in a separate appropriation in the sundry civil bill for the general printing and binding of the Government.

INCREASING DEMAND FOR PUBLICATIONS.

The demand for the publications of this Department continues to increase more rapidly than it is possible to meet them. The policy followed in the past of continuing the distribution after supplying the regular divisional lists, including libraries, agricultural colleges, and stations, exchanges—foreign and domestic—and persons actively cooperating in the work of the Department, to all miscellaneous applicants until the edition was exhausted, and then ordering a reprint to satisfy further demands, while perhaps the best method to be pursued in any plan of unlimited gratuitous distribution, was found very unsatisfactory.

In the first place, the funds at our disposal precluded the possibility of unlimited reprints, and thus, while a great many persons were supplied who undoubtedly did not need the publications they asked for, a large number of persons to whom the publication would prove useful were unavoidably left unsupplied, including very often persons whose services to the Department gave them a special claim on us for our publications. Such a plan might have been satisfactory enough in the days when the demand for the Department's publications was restricted, tho even then it was wasteful; but at the present time to undertake to supply all miscellaneous applicants—and this is the only fair way if the principle of gratuitous distribution is to be accepted—would involve a cost far exceeding any sum which Congress is likely to provide. In the face of the difficulty thus presented to me for solution, I concluded to abandon any attempt at general gratuitous distribution of all Department publications other than Farmers' Bulletins and circulars.

FIRST EDITIONS.

On April 14, 1906, I issued a general order which limited the first edition of every publication to the number of copies necessary to supply libraries, educational institutions, the press, State and foreign officials connected with agriculture, exchanges, and such persons as

render tangible service to the Department, either by actively cooperating in its work or as special correspondents, and including a small number to be reserved for emergencies and for use in correspondence, and to furnish a small supply to be placed in the hands of the Superintendent of Documents for sale. I am indebted to the courtesy of this official for the subjoined statement, showing the total number of the publications of this Department sold by him during the last fiscal year and the sums received therefor, and, for purposes of comparison, the total number sold of all Government publications and the amount received:

Publications of Department of Agriculture.....copies..	47,745
Amount received therefor.....	$5,388.28
All Government publications.....copies..	75,828
Amount received therefor.....	$16,495.88

REPRINTS BY THE SUPERINTENDENT OF DOCUMENTS.

I am also indebted to the Superintendent of Documents for a report showing that under the provisions of joint resolution No. 11, approved March 28, 1904, and with the concurrence of this office, as therein provided, 43 reprints of Department publications were ordered by him from the Public Printer during the year ending June 30, 1906, in editions of from 100 to 1,500 copies, in order to satisfy the requests of purchasers. Under the terms of the resolution referred to, these reprints, which aggregated over 10,000 copies, were paid for from the funds received by the Superintendent of Documents from the sale of our publications. This sale of Government publications under the provisions of the resolution, which authorize him to reprint as occasion requires, defraying the cost of same from the sums received by him as purchase money, affords the most equitable plan for the distribution of these publications to miscellaneous applicants. It involves no waste, meets the requirements of all parties interested at a minimum cost to the Government, and provides for a supply adequate to any possible demand.

To make this system a complete success requires the extensive advertising of the existence of these publications, and to this end this Department supplies each month to all persons desiring it a list of the publications issued during the month previous. By this means, and thru the intelligent courtesy of the press, our publications are widely advertised. A second requirement is, in my opinion, that these publications should be sold at cost of paper, printing, and binding, the cost of the first edition, which includes the making of the plates, being properly defrayed by the Government. A third great convenience would be afforded to intending purchasers if the Superintendent of Documents were authorized to receive postage stamps as cash. This is especially true where the sums involved amount to or include fractions of a dollar.

DEMAND FOR PUBLICATIONS BY EDUCATIONAL INSTITUTIONS.

A great many demands are being made upon us by educational institutions for publications of this Department to be used as text-books, and as these demands usually involve supplying whole classes of students with the same publication, the question promises to present some difficulties. Heretofore I have made it a point to grant such requests, but how long I can continue to do so gratuitously, in the face of rapidly increasing demands of this character, is problematical. In

many cases, especially where there has been cooperation between State institutions and this Department, the number desired is so great that the parties themselves desire the privilege of purchasing hundreds, and sometimes thousands, of copies.

Under the law regulating such matters the Public Printer is authorized to sell not more than 250 copies to any individual, and the applicant must file his order before the publication goes to press. In the cases I refer to this number is generally inadequate, and moreover it is impossible to comply with the condition. There is then left to the institution or official desiring them the alternative of purchasing the plates, with a view naturally to saving the cost of composition. Under the law no saving can be effected in this way. The Public Printer is compelled to charge not only the cost of the metal in making the plates, but the original cost of composition. I would suggest an amendment to the law, authorizing the Public Printer to supply duplicate plates of Government publications at the cost of such duplication, with 10 per cent added for handling, to all applicants duly indorsed by the head of the Department issuing the publication.

BUREAU OF STATISTICS.

SUMMARY OF THE WORK DURING THE YEAR.

The work of the Bureau of Statistics is performed in three divisions: (1) The Division of Domestic Crop Reports, (2) the Division of Foreign Markets, (3) the Miscellaneous Division.

As in former years, the principal work of the Bureau of Statistics has been the collection and dissemination of information regarding the acreage, condition, and yield of the principal agricultural crops of the United States.

The Division of Domestic Crop Reports handles the great mass of reports received from month to month by the Bureau for the use of the Statistician and the Crop Reporting Board in preparing the estimates of the Bureau.

The work accomplished in this division is supplemented by reports received from salaried State statistical agents, one of whom is located in each State, and from special field agents who travel within and thruout defined territory, consisting of two or more States, examining the crops in the field and securing information for the use of the Bureau from all available sources, such as country bankers, agricultural implement dealers, representative farmers, country merchants, and others.

During the year the scope of this work has been very greatly broadened, the increase being approximately 100 per cent. Twenty-five crops not previously dealt with by the Bureau have been added, concerning which reports of condition are made from month to month. This has taxed the working capacity of the clerical force of the Bureau, and has rendered it necessary that they be required to do considerable work above and beyond the regular hours of service ordinarily required.

The special field service of the Bureau of Statistics, as well as the corps of State statistical agents, has been considerably strengthened and the work of these employees has been placed upon a uniform, scientific basis, such as did not formerly prevail. The reports of the Bureau and the methods employed in making them seem to have met with general approval, and have largely increased the confidence of

producers, consumers, dealers, and the public generally in their integrity and accuracy.

In order to prevent the possibility of information regarding the reports of the Bureau being prematurely given out, methods have been adopted which render such leakages impossible. These are explained and described in detail in the annual report of the Statistician of the Bureau. The value of the monthly crop reports of this Bureau has been so thoroly established that any suggestion looking to their curtailment meets with vigorous objection and opposition from all who are interested in the promulgation of fair, unbiased estimates regarding acreages, conditions, and yields of the products of agriculture.

The Division of Foreign Markets compiles information regarding the imports and exports of all the different classes of farm products; also of manufactured products as far as the output of packing houses can be so denominated. The information thus gathered is published annually in bulletins, to which wide circulation is given. In addition to this regular work, studies are made of conditions in countries competing with the United States in the world's markets, with regard to packing-house products and meat animals, and a large amount of instructive matter has been collected and published.

Investigations have also been conducted by this Division of the world's meat trade; of the comparative healthfulness of meat animals in different countries; of the situation thruout the world with regard to cotton production; of the British market for dairy products and its sources of supply; wheat growing in Russia; freight rates, and the world's production and trade in barley, rye, potatoes, wheat, tobacco, cotton, and other agricultural products.

During the past year a very interesting study was consummated upon the subject of the increase in farm values in the United States, the results of which have been published in bulletins which have attracted wide attention and interest.

In the Miscellaneous Division of the Bureau of Statistics, which embraces the statistical library, the necessary translations incident to the work are made; and a few clerks are engaged in special work, such as the compiling and preparing of material to be used in answering inquiries for agricultural statistics made by Members of Congress and others. The services of the clerks in this Division are called into requisition in the tabulation and computation of the monthly crop reports, or for any other purpose for which they may be required.

An employee of the Bureau of Statistics is stationed in London and from that point makes trips to the different European countries, collecting information regarding crop acreages, conditions, and yields, which he sends to Washington each month for publication in the Crop Reporter, a monthly publication of the Bureau, in which are given the reports of the Bureau, placed in comparison with reports for previous years at the corresponding dates, together with various other statistical information of interest to farmers and dealers in and consumers of farm products.

Much statistical work in the way of tabulation and computation has been done for other Bureaus of the Department, and tho the regular work has been greatly increased thru the enlargement of its scope, all the statistical service required by other Bureaus has been accomplished promptly and satisfactorily. The work of the Department is being unified and made cooperative in many lines of research and demonstration.

Investigations have been carried on thru a series of years regarding the cost of producing farm products, and results of these investigations have been embodied in bulletins, which, it is believed, will be of great value and interest.

THE LIBRARY.

The growth of the Library has exceeded that of any previous year, so that at present the scientists of the Department have available for their use a collection of scientific books, periodicals, and pamphlets numbering over 92,000. All new publications of value relating to general agriculture and to special subjects concerning which investigations are being carried on by the Department have been purchased, over 500 periodicals alone being received regularly. This Library is gradually growing to be the most complete collection of agricultural literature in the country. Many valuable purchases and gifts have been included in the 5,000 additions of the past year. For the advancement of work in connection with food and drug regulations, meat inspection, and game protection an unusual amount has been expended for law books and other works published in this country and abroad relative to these subjects. Every new line of work entered upon by the Department makes a correspondingly new demand upon the Library.

CATALOGING.

The card catalog of 160,000 author and subject entries is the most valuable key to the resources of the Library. The cataloging has been kept up to date, so that the material on a given subject is readily available. Cooperation with the Library of Congress and with other institutions which print cards has enabled the Library to secure a larger number of printed cards for its catalog than ever before. These cards are not only for books and pamphlets of its own, but many show what may be found on subjects of interest to this Department in other departmental libraries. By this means the scope of the catalog is largely increased at the least cost of time and money.

The cataloging of the publications of the Department has progressed from year to year until now there is a card catalog to these documents up to the latest bulletin issued. These cards are valued by all libraries receiving our publications regularly, affording as they do the only up-to-date means of reference to all authors and subjects of the publications. On account of the increasing demands for this catalog and of the lack of space in the library for handling and storing the cards, it has been found advisable to transfer the printing and distribution of cards to the Library of Congress. This cooperation has given satisfactory results in the advancement of the work.

Not only is the library indispensable in connection with the work of the Department, but much work has been done in it by visiting specialists, and to many agricultural colleges and experiment stations temporary loans of publications not elsewhere to be found in the country have been made.

OFFICE OF EXPERIMENT STATIONS.

RELATIONS WITH AGRICULTURAL EXPERIMENT STATIONS.

The great value of the agricultural experiment stations as agencies for the advancement of agriculture thru scientific research was recognized by Congress in a signal manner during the past year by

the passage of the Adams Act. This measure, introduced and championed by the late Hon. Henry Cullen Adams, of Wisconsin, had the unanimous approval of the committees on agriculture in both Houses, past in Congress without a dissenting vote, and received the approval of the President March 16, 1906. It provides that each State and Territory shall annually receive from the National Treasury a grant of money in addition to that given for the establishment and maintenance of agricultural experiment stations by the act of March 2, 1887 (Hatch Act). The initial appropriation to each State under the Adams Act is $5,000 for the fiscal year 1906. To this amount $2,000 is to be added each year for five years, after which an appropriation of $15,000 is to continue annually. Thus in 1911 and each year thereafter each State will receive $30,000, double the amount hitherto granted under the Hatch Act. The new act recognizes the fact that thru previous National and State legislation the stations are thoroly organized, are equipped with lands and buildings, and have funds for the printing and distribution of publications.

The extension and strengthening of the experimental work of the stations is therefore made the sole object of the Adams Act, and the additional funds are "to be applied only to paying the necessary expenses of conducting original researches or experiments bearing directly on the agricultural industry of the United States." The Adams fund is thus essentially a research fund, and if properly used should produce results of the greatest and most permanent value to American agriculture. The State experiment stations have already performed service of great value. They have done much to secure radical and wide-spread improvements in agricultural practise; they have contributed in large measure to the creation of a new American literature of agriculture and made it available to every farmer; they have collected much of the material from which a science of agriculture is being formulated as the basis for the instruction of successive generations of farmers in colleges, schools, and farmers' institutes. As their work has developed, it has naturally divided itself into several broad classes, which may be briefly summarized as (1) original research; (2) verification and demonstration experiments, often of a local character and import; (3) inspection service; and (4) dissemination of information. So great has been the local pressure for work of the last three classes that by far the greatest share of the National and State funds have been spent in these lines. The Adams fund now comes in to enable the stations to broaden and deepen their original researches, on the results of which largely depends the success of their other work.

Previous to the passage of the Adams Act the funds of the stations from sources within the States had steadily increased, until in 1905 they exceeded the revenue derived from the National Treasury. There is every reason to believe that the States and local communities will continue to deal liberally with the stations, and that thus they will be able to extend their more popular and directly practical work. The United States will thus have a much more thoro and comprehensive system of agricultural experiment stations.

Congress having put in my hands the administration of the Adams Act, I have assigned to the Office of Experiment Stations the duty of dealing with the experiment stations in matters relating to this act.

The untimely death of Mr. Adams has taken away one of the foremost leaders in the cause of agricultural progress in this country. His clear insight into agricultural problems and needs, his thoro sym-

pathy with farmers, his appreciation of the benefits accruing to agriculture from the work of properly trained scientists, his independence of thought and action, his fearless advocacy of measures which he deemed of importance to agriculture, his experience in public life both as an administrator and as a legislator, his thoro honesty, which won the respect and confidence even of those who opposed him, put him in a position to render the highest and best service in National councils and legislation. In consideration of the important social and economic changes which our rural communities are passing thru in these days, as well as of the vast material interests involved in our agriculture, the loss of such a leader is most keenly felt. Great, however, was his achievement in the short period in which he was a member of Congress, for the name of Representative Adams, of Wisconsin, will ever be linked with that of Senator Morrill, of Vermont, and Representative Hatch, of Missouri, as the author of a measure of fundamental and permanent importance to the institutions which advance and disseminate the knowledge on which our agricultural progress and permanent prosperity largely depend.

THE AGRICULTURAL COLLEGES AND SCHOOLS.

In response to demands from numerous sources the work of the Department relating to agricultural education has been gradually broadened, until now it touches nearly every phase of the subject. This Department, thru the Office of Experiment Stations, has been active in aiding the establishment of agricultural high schools and the introduction of agricultural subjects into the curricula of the public schools. Representatives of that Office have addrest important educational and agricultural meetings in the interests of agricultural education in a number of States, have given advice regarding legislation and courses of study, and have assisted in the inauguration of agricultural instruction and the securing of agricultural teachers in different localities. The agricultural colleges have been visited and conferences have been held with their officers and teachers. A special study has been made of the agricultural work in the colleges for negroes.

The general interests of higher education in agriculture have been promoted thru cooperation with the Association of American Agricultural Colleges and Experiment Stations. As chairman of the standing committee on agricultural instruction, the Director of that Office has aided in studies with reference to the improvement of courses of instruction in the agricultural colleges and schools. He has also acted as dean of the Graduate School of Agriculture, which held a second successful session at the University of Illinois the past summer. The faculty of this school consisted of 35 of our leading agricultural teachers and experts from this Department and the agricultural colleges and experiment stations. The students, drawn from 34 States and Territories, were mainly the younger men already engaged in agricultural teaching and experimenting.

With the development of the Department's work along educational lines it has become clear that it may accomplish important and valuable service as a central agency for the promotion of agricultural education in cooperation with the State departments of agriculture and education, the agricultural colleges and experiment stations, and the State and National agricultural organizations. The most important

lines of educational effort in which the Department should engage may be briefly outlined as follows:

(1) To aid the agricultural colleges to reduce the results of the investigations made by this Department and the experiment stations to pedagogical form for use in agricultural colleges and schools of different grades. This work is now proceeding too slowly to keep pace with the accumulation of material, and the lack of well-ordered manuals and illustrative materials is a great hindrance to the effective organization of agricultural instruction.

(2) To promote the efficiency of agricultural instruction in the negro land-grant colleges, in order that the funds granted for negro education by the Federal Government may contribute toward keeping the negro on the farm and making him a more efficient factor in agricultural production for his own good and that of the nation, rather than, as is largely the case at present, drawing him away from the farm into the uncertainties and dangers of city life.

(3) To aid the agricultural organizations in the several States in promoting an efficient organization of agricultural high schools, consolidated common schools, and other educational agencies best adapted to secure a high state of prosperity and contentment in rural life. It is along these lines that the great educational effort of the immediate future is to be made. The forces behind the movement for industrial education have hitherto devoted themselves very largely to the promotion of instruction in the city industries. It is now apparent that a similar work needs to be done for the great fundamental industries grouped under agriculture. Much work will be required to bring the masses of our agricultural population into sympathetic touch with the progressive movement in education and to secure for them a school system in harmony with their environment and their relations to the world's work and civilization. As the nation's representative of agricultural enlightenment and progress, this Department should be in a position to render effective aid in this enterprise, on the success of which depends so largely the permanent prosperity and contentment of our agricultural people.

(4) Since the success of agricultural instruction in the public schools will depend very largely on the teachers, this Department should aid the agricultural colleges and other State educational institutions in preparing and inaugurating training courses for teachers of agriculture in secondary and elementary schools.

(5) Since agriculture as a fundamental industry is of vital importance to all our people, this Department should present such results of its work and that of the experiment stations at home and abroad as are adapted to instructional purposes in connection with nature study and elementary agriculture in a form available to teachers and pupils in both country and city, the object being to impress our youth with the dignity, value, and attractiveness of country life and pursuits.

THE FARMERS' INSTITUTES.

Interest in the farmers' institutes continues to increase thruout the country, and a larger attendance is reported for the past year than ever before. The Department is keeping in close touch with the State organizations under which the institutes are held, and is especially aiding the lecturers to obtain up-to-date information regarding the progress made in agricultural science and practise. In many localities there is a demand for more extended and definite instruction than

can be given in the ordinary institutes. The Department is therefore having short courses of lectures prepared by experts, which may be used in so-called movable agricultural schools. Inquiry is also being made regarding the value of various other means more or less extensively used for interesting farmers and their families in improved practise on their farms and in their households. Representatives of the Department have accompanied the special railroad trains which have carried exhibits and lecturers to thousands of farmers in many parts of the country and have proved popular and effective means of awakening interest in the work of the Department and the experiment stations. The farmers' institutes and other forms of what is often called extension work in agricultural education are very important supplements to the publications of the Department and the stations, as well as to the regular work of the agricultural colleges and schools. The Department should share in this extension work and seek to promote its general interests.

EXPERIMENT STATIONS IN ALASKA, HAWAII, AND PORTO RICO.

A systematic effort has been begun to determine the feasibility of the live-stock industry in Alaska. A small herd of Galloway cattle has been purchased and located at Kenai, in Cook Inlet, and at Wood Island. These cattle have subsisted during the summer upon the native grasses, and a considerable supply of grain hay has been grown at the Kenai Station with which to maintain them during the winter. Wheat, rye, barley, and oats matured in 1905 and 1906 at the Rampart Station in the Yukon Valley, but 300 miles farther south, in the Copper River Valley, cold and drought killed all but the hardiest varieties of cereals. A large amount of grain hay was obtained at the Copper Center Station and sold at a highly remunerative price. It has been shown that many of the Alaskan soils require lime, and a method has therefore been devised for the cheap local production of lime in small quantities. Arrangements have been made to open a station near the prosperous mining towns of Fairbanks and Chena, on the Tanana River, as soon as funds are available for this purpose.

The Hawaii Station reports an increasing appreciation of its efforts toward diversifying the agricultural industries of the islands, and as a direct result of three years' experimental work with tobacco it is said that this year fully 200 acres were planted. The discovery by the station chemist that Hawaiian feeding stuffs are deficient in lime is an important one, and will make it possible to arrange more satisfactory rations for live stock. The investigations on the marketing of tropical fruits promise to open markets in the Pacific coast, which can best be supplied from Hawaii. Investigations begun with the object of rehabilitating the rice industry have been so favorably received that private individuals have generously contributed considerable sums of money to aid in carrying them on.

The Porto Rico station is extending its influence, and requests for cooperative work are coming from numerous sources. While the income of the station has been too limited to enable it to meet these demands, yet they show a growing sentiment in favor of the station which is very encouraging. The coffee experiments have begun to show results, and the improved methods of pruning and cultivation are quite apparent in the increased yields obtained. A successful effort is being made to grow lowland rice, and this industry should be greatly extended. The Porto Ricans are large consumers of rice, most of

which is now imported. Among the forage crops experiments with cowpeas have been most successful, and it is believed that they can be grown thruout the island. Numerous horticultural experiments are in progress, and studies are being made of insect pests and plant diseases.

The work of the stations in Alaska, Hawaii, and Porto Rico is now so well established that they can profitably make use of increased funds. Considering the fact that all buildings, equipment, and live stock must be provided for these stations from the Federal funds, there is even greater need of more liberal appropriations for their maintenance than in the case of the State experiment stations. I therefore recommend that an appropriation be given to the stations in Alaska, Hawaii, and Porto Rico equal to the amount given the State stations under the Hatch and Adams acts.

PROGRESS IN NUTRITION INVESTIGATIONS.

The investigations on the food and nutrition of man, conducted in different States and Territories under the auspices of the Office of Experiment Stations, have, as in the past, been carried on in cooperation with universities and other schools, as well as public institutions, but chiefly with agricultural experiment stations and agricultural colleges. By this cooperation the Department funds have been materially supplemented in various ways and the scope and possibilities of the work greatly increased. The chief object of the investigations is to learn the nutritive value of agricultural products of animal and vegetable origin and the proportions in which such food materials of different kinds may be most intelligently used to the advantage of both producer and consumer. The general policy has been to undertake, in the different centers of investigation, work for which the institution or region offered exceptional facilities. Thus, at the California Agricultural Experiment Station studies have been undertaken with fruits and nuts and the products made from them; at the Minnesota and Maine experiment stations with wheat, corn, and other cereal foods; at the University of Tennessee with cowpeas and other legumes; and at Wesleyan University, Middletown, Conn., with cheese made and cured in different ways. New experiments have been undertaken whenever the finishing up of any line of work has rendered this possible, and it has been the purpose to select for study especially those problems which have a direct bearing upon agriculture.

The experiments which have been conducted at the California Agricultural Experiment Station have furnished additional evidence of the considerable amount of nutritive material which may be supplied in readily digestible form by fruits and nuts intelligently used as part of the diet. It appears further that fruits and nuts are more useful when eaten in combination with other food materials than in large quantities by themselves or at the end of an otherwise hearty meal.

The studies of cereal breakfast foods undertaken at the Maine and Minnesota experiment stations have shown that different classes of goods made from the same grain do not differ materially in nutritive value tho there is a considerable range in price. As a whole, cereal breakfast foods are nutritious and reasonably economical. As regards digestibility they closely resemble bread made from the coarser flours and are somewhat less thoroly assimilated than bread made from white flour. It has also been shown that flour products other than bread closely resemble bread in digestibility and total nutritive value.

From studies with corn products, undertaken at the Maine Experiment Station, it appears that corn bread of different sorts has about the same digestibility as bread made from coarse wheat flour, and that it is well worthy of a place in the diet as a reasonably inexpensive source of nutritive material, as well as for the sake of variety.

The studies of different methods of cooking meat carried on at the University of Illinois have shown that it is possible to control cooking processes so that a fairly uniform product may be obtained when similar cuts of meat are cooked by either boiling or roasting. As a whole, meats of different kinds and cuts supply nutritive material, particularly protein and fat, in forms which are very well assimilated.

Investigations on the digestibility and nutritive value of cheese carried on at Middletown, Conn., have shown that cheese (American cheddar) is very thoroly assimilated and is not productive of digestive disturbances as commonly supposed. When desired it may be used in comparatively large quantities as an inexpensive source of protein and energy in the diet. Cheese, being rich in protein and fat, should be combined with cereal foods, fruits, and similar products, which supply an abundance of carbohydrates, and when eaten in considerable quantities should replace rather than supplement such nitrogenous foods as meat, eggs, and dried legumes. The experiments furnish the first extensive demonstration by scientific methods of the high nutritive value of this important dairy product. The great importance of cheese as a source of protein has not been hitherto appreciated and in a sense its commercial value as a food has lacked satisfactory basis.

The investigations carried on with the respiration calorimeter at Middletown, Conn., have furnished new and valuable factors regarding the average amount of energy in the form of food required by men at rest and performing various kinds of work, the carbon dioxid and energy output at different times of the day under different conditions of work and rest, and related topics.

The investigations undertaken at the Hawaii Agricultural Experiment Station have furnished interesting data regarding the nutritive value of tropical food products and the kinds and amounts of food consumed by persons living under different circumstances in tropical regions.

At Columbia University, New York, the investigations which have been undertaken furnish new and valuable data regarding the demands of the body for the ash constituents of food.

The results of the nutrition investigations are made public by means of technical bulletins and popular summaries, and a great deal of miscellaneous information is also supplied to teachers, students, and other persons by means of correspondence, the increasing demand for publications and other data being an indication of the favorable way in which the work is regarded by the people at large.

Extended use has been made of the nutrition publications as text-books in a large number of schools, colleges, and medical schools thruout the country, owing to the fact that satisfactory text-books on these subjects have not hitherto been available. In this connection it may be mentioned that there are 45 agricultural colleges or similar institutions receiving Government aid for white students, and an equal number for colored people, where some of the courses of instruction necessitate the use of such data.

The proper economical feeding of families or groups—that is, the best methods of utilizing the food products which come from the farm—is a subject the importance of which can hardly be overestimated, and a knowledge of the important facts regarding the nutritive value of different foods can not fail to bring about improved standards of living on farms and elsewhere and benefit alike the producer, distributer, and consumer of food products.

IRRIGATION AND DRAINAGE INVESTIGATIONS.

Three years ago the Office of Experiment Stations detailed some of its irrigation experts to work out and introduce the right methods of irrigation in some of the older districts where water is scarce and costly and where skill and economy in its use are of the utmost importance, and also took up giving practical advice to beginners in irrigation in sections where irrigation was being introduced. The conditions under which these men worked therefore were widely different, but the results have been the same in each case. Wherever this educational work was begun there has been a marked appreciation of its value. Each one of these men has become a fixture in the State and section where he was first located. Every attempt to send him to a different section to take up this work has been met by protests and remonstrances which could not be disregarded. The result has been that requests for similar work in other localities made by Members of Congress, governors, and communities could not be responded to, altho the value of the work and the reasonableness of the requests were fully appreciated. To meet these demands the number of men engaged in this work should be increased during the coming year.

Thus far this work has been carried on entirely in aid of settlers under private works, but it is believed that the time has come when this Department should take up the work of educating and aiding settlers under Government reclamation projects, and that experts should be detailed to these projects to show the methods of applying water which should be adopted, the kind of tools to be used, the time when land should be irrigated, the quantity of water which should be used, and the cultivation which should follow this use.

The experience of the past few years has also shown that this educational work and the successful conduct of original investigations can both be best carried on thru the establishment of farms where the best methods can be worked out and illustrated and their results demonstrated. While bulletins and reports are of great value, they are not equal to an object lesson. Nothing will teach these farmers how they should do their work so quickly as to be able to see fields prepared in the right way, water handled in the right way, and the soil cultivated in the right manner. I believe therefore that on each reclamation area a demonstration farm should be established, on which the methods of irrigation can be taught by a practical expert from this Department, and trust that provision will be made for this by the next Congress.

Five irrigation extension stations for the demonstration of methods of using groundwater and flood and storm waters in irrigation as supplementary to dry farming have been located in the semiarid belt during the past year. At these stations it is expected to work out and demonstrate the methods and practises for utilizing limited water supplies in the irrigation of from 1 to 10 acres of land, and the methods of irrigation and tillage needed to conserve this moisture in the

soil, and the benefits which will come by making such irrigation a feature of every semiarid farm. This work has assumed a new importance because of the great wave of settlement which is now sweeping over this region.

A number of influences, some of them proper and some questionable, are aiding in this settlement. Among those that are legitimate are the greater possibilities due to the introduction of drought-resistant crops, the improved methods of tillage, and the series of wet years with which that section has been favored. But there will come other dry years, and the permanent prosperity of these settlers will largely depend upon their having fortified themselves against the risk of drought by utilizing every opportunity for a water supply that the region affords. Nothing will aid more to enhance their comfort or relieve them from the danger of dry years than to have from 1 to 10 acres of land irrigated where crops can be grown regardless of the rainfall. Provision for such irrigation will enable the farmer to grow trees for fruit and shade, have a limited area of high-priced products, enough vegetables for his family, and forage for his cows and horses. It will also enable him to make the surroundings of his homestead attractive, thus adding to the comfort and contentment of country life in these regions.

That the demonstration farm is an effective influence in promoting the extension of this kind of irrigation has been proven by the results of the oldest of these stations located at Cheyenne, Wyo. This station, thru the utilization of underground waters lifted by windmills, has produced crops equaling those of the old irrigated districts. It has shown the extent and value of water resources hitherto neglected. The station was visited during the year by fully 5,000 people, and its methods and results observed and described in a large number of scientific newspapers and magazines, as well as the local press of that region. It has encouraged a large number of farmers to conserve and utilize water supplies which were hitherto going to waste, and the year's results are considered as marking the beginning of a new era of agriculture in that section.

In many parts of the arid and semiarid region water for irrigation can be secured only by pumping. The Department has a constant call for information as to the cost of such irrigation and the types of pumps and the kind of power which should be used. We have collected a large amount of information on these subjects, which is now being prepared for publication, and recently have inaugurated some comprehensive tests to determine the value of alcohol as a power agent in pumping water for irrigation and drainage, and in other agricultural work, with a view to giving practical information to farmers about the value of denatured alcohol as compared to gasoline, and the conditions under which it should be used to secure the maximum efficiency.

Every year the area of irrigated land that needs drainage is increased, which proves that irrigation and drainage must go hand in hand. During the past year the Department has been carrying on extended drainage investigations of some of the irrigated districts injured by surplus water in Utah, Washington, Nebraska, and California, this work been paid for in part by State appropriations. These investigations have been carried on as a preliminary step in the preparation of drainage plans.

The past year has also demonstrated the benefits of good engineering in securing the efficiency of drainage as a remedy for alkali. The drains put in by the farmers of Utah on lands which were regarded as ruined by alkali have so relieved the lands in a single year that they are now ready for cultivation, and land drained three years ago according to plans prepared by the engineers of this Department, this year produced $75 worth of sugar beets to the acre. Equally encouraging results on a larger scale have followed the carrying out of the plans of the Department's engineers in the State of Washington.

The drainage of the swamp overflowed lands in the humid parts of the United States would extend or greatly improve agriculture over an area almost equal to that of the States of Illinois, Indiana, and Ohio. This makes farm drainage a matter of National interest and importance. Nor will the increase in agriculture mark the full measure of the benefits of this drainage. Many of these swamps are a menace to the health of surrounding neighborhoods and a great obstacle to the development of commerce and manufacturing. The reclamation of some of these areas, like the coastal swamps of the Carolinas, the Everglades of Florida, and the St. Francis Basin in Arkansas, presents agricultural and engineering problems of great complexity, which can not be solved by private enterprise; the cost and the area of country involved are both too great. As a rule agricultural drainage requires special legislation to provide for the organization of the district to be benefited and the raising and expenditure of funds under public or semipublic authority. The general interest manifested in drainage in this country and the large amount of work done at present, has given rise to many important questions, legislative, financial, engineering, and agricultural. The calls on the Department along these lines have been far greater than could be met. During the past year it has rendered important aid by conferences with State officials and others in making surveys and investigations to determine the feasibility of large drainage projects and prepare plans for the work. During the year this Department has carried on these surveys and investigations in thirty-one of the forty-six States.

OFFICE OF PUBLIC ROADS.

Thruout the country, and more particularly in the rural districts, there is a steadily growing demand for information as to the best methods of road construction. Considering the country as a whole, it is probably true that in no phase of development are we so backward as in the extension of hard and durable roads. In the cases in which the people are willing to expend money on the improvement of their highways, it frequently happens that, owing to inexperience and lack of organization, the money is partially or totally wasted. In some communities abundantly able to support a system of good roads, very little work is done, owing to a lack of knowledge of what can be accomplished with the resources at hand. It is precisely in cases like these that the work of the Office of Public Roads is proving of signal value. While it is no part of the scope of its work to undertake the construction of roads that can be and should be the care of communities within the States, the educational value of employing expert supervision, as well as, to a limited extent, machinery for the construction of sections of improved roads in different parts of the country, has been amply demonstrated.

The act of Congress making appropriation for the Office of Public Roads makes three distinct requirements in relation to the work to be performed, viz, to investigate systems of road administration thruout the United States, to give expert advice on road construction, and to investigate the chemical and physical properties of road materials. During the past year the work of the Office has been arranged in three general divisions along the lines indicated.

The Office is also collecting information as to comparative cost of road work, methods of building various types of roads, State-aid roads, legislation regarding road management, the value of wide tires, the use of convict labor in road building, cost of wagon transportation, and bond issues for road improvement. Numerous inquiries are received asking for information on the subject of the road laws of the various States, and a complete digest of the road laws of all the States is being prepared for publication.

EXPERT ADVICE ON ROAD CONSTRUCTION.

Expert advice on road construction has been given and experimental field work carried on by the Office. There were employed on this work at the close of the fiscal year, in addition to the chief engineer, 3 engineers, 1 consulting engineer, 6 engineer students, 6 road experts, and 5 expert roller operators. Whenever it is possible and where application has been made in the proper way, object-lesson roads are constructed for the purpose of illustrating the best methods of road building. The local authorities furnish all material, common labor, teams, and fuel, the Office supplying supervising engineers and in some cases part or all of the necessary machinery. In addition to this, tests are made to determine the best material available for the road. It frequently happens that these short sections of object-lesson roads have subsequently led to the construction of fine systems of improved roads in the localities in which they were built. During the past fiscal year 17 roads were built in 11 States, representing a wide diversity in character of construction and kinds of material used.

In many cases in which it is not deemed advisable to undertake the construction of an object-lesson road, engineers and experts of the Office are able to give advice that enables local authorities to improve the conditions and surmount difficulties. It is evident that where only small amounts of money are available for road improvement it is frequently better to improve the highways already existing than to attempt the construction of macadam roads. Special attention has been given to this phase of the work and the Office has been able to do much in developing the use of sand clay and burnt clay for roads in large areas of country, especially in the South, where no stone is available.

In order to give expert advice on special problems which are continually arising in road construction and maintenance, it is necessary to carry on experimental work. During the past year methods of rendering roads dustless have been investigated. The growing use of motor vehicles has presented a new and difficult problem to engineers and road builders. Systematic experiments were carried on at Jackson, Tenn., during the spring and summer of 1905, in cooperation with the city engineer, to determine the value of coal tar for preventing dust and preserving the surface of macadam roads. Tests were also made with Texas oil and its residuums on earth and macadam roads. The

expense entailed in these experiments was small. The quantity of tar applied per square yard averaged 0.45 gallon and the cost of labor for applying this quantity of tar was less than 1 cent per square yard. After more than seven months, including the winter season of 1905-6, the tarred roads are still in excellent condition.

Additional experiments were conducted during the summer of 1906 on the Potomac River drive in Washington, D. C., in cooperation with the Superintendent of Buildings and Grounds. Crude coal tar similar to that used at Jackson, Tenn., was used in this work. These experiments have been completed but a short time. The great demand which exists all over the country for some sort of treatment of road surfaces to suppress the growing dust nuisance has developed a number of materials which it is claimed will answer the purpose. Many of these materials, which are mainly emulsions of oil and tar with water, have been given trade names and patented. It is to be hoped that careful experiment will show that some material like crude coal tar, which can be obtained and easily applied wherever there is a gas plant, will prove to be efficient if properly used. It may be said that a large number of trials of crude tar in France and a few in this country, notably the one at Jackson, Tenn., have given excellent results. In other cases partial or entire failure has followed the experiments, and it yet remains to be determined whether the successful use of materials of this nature can be developed. The Office will make unremitting efforts to solve this problem by such experiments as can be carried on in different parts of the country in cooperation with local authorities.

In order to recruit the ranks of engineers that are necessary to the success of the work of the Office, the plan was adopted of appointing graduates from civil engineering schools to the positions of civil engineer students, as fully explained in the annual report of the Office of Public Roads for 1905. Up to June 30, 1906, nine students had been appointed, at $600 per annum. Of this number three have been given permanent appointments at increased salaries. The other six have not yet completed the one-year course.

A number of schools and colleges have within recent years established summer schools in road building.

INVESTIGATION OF THE PROPERTIES OF ROAD MATERIALS.

During the past year 384 samples were received at the laboratory for routine tests, of which number 273 were samples of rock, intended for macadam road building. Of the 273 samples received, about 42 per cent were limestone, 11 per cent dolomite, 10 per cent trap, 8 per cent sandstone, and 8 per cent granite. The remaining samples were of a miscellaneous character, including brick, cements, and sand. Some of this testing work is done in cooperation with various Departments of the Government. A comparison of the demand for tests with the records of previous years shows that it has increased about 33 per cent.

A significant fact, in connection with the laboratory work, is that a very large number of samples have come from the Eastern and Middle States, which have not received much assistance in the form of object-lesson roads. This tends to distribute uniformly the benefit arising from the work of the Office.

There is a growing amount of cooperation between the various State geologists and the Office in the preparation of data showing the character of material suitable for road work in the different States. From one State alone more than 80 samples have been tested. The information thus secured has been used in a bulletin, recently prepared and published by the geologist in charge, on the road-building resources of this State. Chemical and physical examinations have included practically all materials which directly or indirectly come into use in road construction.

The studies of decomposition of various kinds of rock dusts under the action of water, which were undertaken in order to determine the reasons for the important quality of binding power in macadam-road materials, has brought to light some specially interesting facts. For instance, it has been found that by mixing certain rocks of inferior binding power on the surface of the road a much higher binding power results, as in the case of limestone and granite. As the binding or cementing power of rocks is one of the chief factors in the life of a road, the value of this discovery is of obvious importance. These results, originally obtained in the laboratory, have been confirmed by observation and experiment on roads. In the course of this investigation it was found that the decomposing action of water on certain types of ground rocks went much further than had been previously believed to be the case. This applies to the alkalies, and especially the potash, contained in many rocks. The results have suggested the possible use of ground rock as a potash fertilizer. Work along this line has now been turned over to another Bureau of the Department, where it can be appropriately followed up and carefully investigated.

Owing to the numerous complaints of farmers in regard to the rapid deterioration of the modern fence wire in comparison with that manufactured in former years, an investigation of the subject was begun to see what could be done to remedy the defect. Farmers' Bulletin 239 contains a report of this investigation, which has aroused the interest of manufacturers and has determined some of them to take active steps toward producing a fence wire more resistant to atmospheric corrosion.

The scarcity of timber in many sections of the country, not only for construction work, but for fence posts, has in recent years led to a more general use of concrete. This material is admirably adapted for farm purposes, but there seems to be a general lack of knowledge concerning its preparation and use. After a series of tests and investigations, Farmers' Bulletin 235 was issued, giving full information concerning cement, cement mortar, the mixing of concretes, and the construction of concrete sidewalks, driveways, fence posts, etc. A number of persons thruout the country who claim to have obtained special patents on concrete fence posts have attempted to prevent farmers from constructing their own posts by threats of prosecution for infringement. In view of the fact that concrete construction of all kinds reenforced with plain, straight, metal strips, bars, and tubes has been in general use in all countries for many years, the claims of such persons are usually without warrant. The Office has been enabled to be of great service to farmers by making it clear to them that, unless special forms and devices of reenforcement were employed which were distinctly patentable, no rights were infringed by the use of concrete with plain metal reenforcement.

Before being assigned to work in the field the engineer students employed in the Office receive a course of instruction in the testing laboratory. This work consists in actually making the various tests of road materials and computing results. The information thus obtained is considered necessary in connection with the selection of the best materials for road construction before a thoro understanding of the relations which exist between laboratory tests and the behavior of these materials under traffic can be gained.

A number of new projects and lines of investigation have been mapped out for the immediate future.

Outside of the laboratory a study of road machinery will be undertaken to determine the suitability of various types for different kinds of road work.

Cooperation will be sought with the Geological Survey for the purpose of indicating the various classes of roads on topographic maps issued by the Survey. Cooperation has been begun with the Forest Service in laying out and constructing wagon roads and trails in forest reserves to facilitate lumbering. As a beginning one engineer has been detailed to this work and has been some months in the Yellowstone Reserve. The field report indicates that much good will follow the preliminary survey which has been made.

Cooperation with the Post-Office Department has been begun in order to facilitate rural delivery by the improvement of country roads. This work is of vital importance. The plan, which carries the approval of the Secretary of Agriculture and the Postmaster-General, provides that whenever a road upon which a rural route has been or is about to be established is reported by the carrier or inspector to be impassable or in bad repair, the Fourth Assistant Postmaster-General will advise the Director of the Office of Public Roads of the fact and request that he have an engineer inspector detailed to examine the road and give such advice and instruction to the local officials as may be required.

Upon receipt of such information from the Fourth Assistant Postmaster-General, the Director of the Office of Public Roads will communicate with the local officials and supply them with a copy of the circular of instructions and a blank form for making application for the detail of such engineer inspector. It is not the purpose of the Office of Public Roads to actually construct the road or to make any contribution in money, materials, or labor. In most cases a road is impassable on account of defects which can be remedied by the use of proper methods. The engineer inspector who examines the road will note carefully all such defects and advise as to what steps can be taken to place the road in proper condition without great expense. If practicable, and if so desired, he may in some cases assume temporary direction of the work for the purpose of instruction.

As the chief aim and purpose of the Office of Public Roads is to bring about a general and uniform improvement of the country roads thruout the United States, a cooperative plan such as the one described above offers the best possible means of achieving positive results in furtherance of that purpose. By this means correct methods of road building and road maintenance will be introduced into practically every section of the country. The engineer inspectors assigned to this work will, in visiting places which have requested assistance of this character, follow an itinerary which will include a number of places in a given territory. This will greatly minimize the expense of each

inspection and permit the inspector to cover a much larger territory than would be possible in a special assignment to each place. A beginning has been made during the current fiscal year, and efforts will be made to increase the scope of the work in the future.

EXPENDITURES AND EMPLOYEES.

Congress appropriated $7,175,690 for the maintenance of the Department of Agriculture for the year ended June 30, 1906. This was $1,081,150 more than the appropriation for the preceding year. In addition the Department received from various sources, chiefly sales of products, $15,473.45. At the close of the year there was still unexpended, of the appropriation, $1,175,362.15, nearly all of which will be required to meet outstanding obligations. The unexpended balance for the year 1904 ($55,712.37) was, on June 30, 1906, covered into the Treasury. The account for 1905 was still open. Of the special appropriations aggregating $1,250,000 for new buildings, $642,107.25 had been expended prior to September 10, 1906.

For the current year (ending June 30, 1907) Congress appropriated $9,210,440 for the regular work of the Department. The increase is chiefly due to the broadening of the meat inspection. For that service the permanent appropriation is $3,000,000. The estimated revenues of $700,000 from sales of products of the forest reserves and $780,934.68 available for the new buildings bring the total amount to be disbursed by this Department during the current year up to $10,691,374.68.

The number of persons on the rolls of the Department of Agriculture on July 1, 1906, was, outside of Washington, 4,648; in Washington, 1,594; total, 6,242, showing an increase during the year of 796. Of the total number, more than 1,800 have been on the rolls for six years or longer. In the classified service 917 were promoted in salary and class, and 403 resigned. The total number of deaths during the year was 28.

NEW BUILDING FOR THE DEPARTMENT.

The act approved February 9, 1903, authorizing an appropriation of $1,500,000 for a new building, made possible the beginning of the construction of suitable quarters for the accommodation of the Department's work.

It was very necessary in the new building operations to make arrangements for future requirements, and with this in mind, together with the imperative need for suitable laboratories to carry on the important investigations of the various Bureaus, it was concluded to erect two segments of a building, so arranged that extensions could be provided as required, these segments to be used primarily for laboratory work and to provide fireproof accommodations for the Library. Contracts have been awarded for structures of suitable type and design to correspond with other Government buildings in the city, the base being constructed of granite and the superstructure of white marble.

The work has now progressed, with the exception of the interior finish, to approximately the fourth-floor line, and it is probable that the roof will be on before the winter season. The roofing and closing in will allow the interior work to be carried on during the winter without interruption, which, without unforeseen complications, will

insure the completion of operations within the contract time, namely, November 14, 1907, and within the $1,500,000 authorized by Congress. The mechanical equipment work, including the heating and ventilating apparatus, the electric wiring and conduit systems, and the electric elevators, has been started, and these systems will be ready for use at the time of the completion of the buildings.

The estimated growth of the Department, made at the time the appropriation for the new building was approved, has been greatly exceeded. Statistics show that there has been during this period of approximately three and one-half years, exclusive of the Weather Bureau, an increase in the number of employees of from 1,037 to 1,483 in Washington, D. C., making a percentage increase of 43. Further, the space required by this force of employees has increased from 137,963 square feet to approximately 264,000, this being a 99 per cent increase, and the rentals paid from the Department appropriation have increased from $21,700 to $54,408.96, or over 150 per cent.

This rapid increase will require other segments of the proposed buildings to be constructed before the Department will have sufficient and suitable accommodations for its work and before the large amount paid annually for rentals can be substantially decreased.

To carry on the work of the Department in an efficient manner on the lines laid down in the foregoing report has necessitated provision for somewhat increased appropriations. This report will fall short of its purpose if it has not made clear the importance of the interests the Department is designed to serve, and the necessity for carrying on its work. Moreover, the duties devolving upon it are imposed upon it by law, and it is with full appreciation of these several considerations that estimates for its expenses must be viewed. The estimates for the ensuing year have been most conservatively prepared, based upon the lines of work imposed upon the Department by the Congress, and I earnestly commend them to the favorable consideration of that body.

Respectfully submitted.

JAMES WILSON, *Secretary.*

WASHINGTON, D. C.,
November 24, 1906.

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Issued May 25, 1907.

U. S. DEPARTMENT OF AGRICULTURE.

Report No. 84.

PROGRESS

OF THE

BEET-SUGAR INDUSTRY

IN

THE UNITED STATES

IN

1906.

WASHINGTON:
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LETTER OF TRANSMITTAL.

U. S. DEPARTMENT OF AGRICULTURE,
BUREAU OF PLANT INDUSTRY,
OFFICE OF THE CHIEF OF BUREAU,
Washington, D. C., March 25, 1907.

SIR: I transmit herewith the manuscript of the annual report on the Progress of the Beet-Sugar Industry in the United States in 1906. It consists of the report of the special agent, Charles F. Saylor, and a brief account of the lines of study and investigation pursued by the regular force of this Bureau.

I recommend that this manuscript be published as Report No. 84 of this Department.

Respectfully,

B. T. GALLOWAY,
Chief of Bureau.

Hon. JAMES WILSON,
Secretary.

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PROGRESS OF THE BEET-SUGAR INDUSTRY IN THE UNITED STATES IN 1906.

REPORT OF THE SPECIAL AGENT,

CHARLES F. SAYLOR.

INTRODUCTION.

I can not better introduce my tenth annual report on the progress of the beet-sugar industry in this country than by stating that the year 1906 has been in all respects the most successful year since the beginning of the industry in the United States.

We are now producing enough sugar (from beets and cane) in the United States to supply the population in the western two-thirds of our entire area, or enough to supply nearly one-third of the whole amount of sugar consumed in the United States. The beet crop has been bountiful in all sections of the country. Factories have received larger supplies of beets than at any other time, many of them more than it was practicable to manufacture into sugar. During the past year more plants have been built and considerably more capacity for manufacturing sugar has been installed than in any preceding year. The prospects at the present time are encouraging for 1907, and, in fact, the continuous development of this industry seems assured.

LAST YEAR'S FORECAST.

As a feature of my last report I took occasion to illustrate the magnitude of the sugar industry in the area lying west of the Mississippi River by comparing the estimated production of sugar in 1906 with the consumption of sugar in that area in 1900. This estimate showed that under normal conditions this region of our territory would have sufficient sugar-producing capacity to manufacture considerably more sugar in 1906 than the estimated consumption of that section for the last census year (1900). I attempted to portray graphically the results of the rapid development of this industry. To state in tons the amount of sugar produced suggests to the average reader an indefinite idea as to the real magnitude of the industry, but the state-

ment that the population west of the Mississippi River is producing a surplus of sugar over and above its consumption conveys a startling fact which very few have realized. This graphic presentation had precisely the effect intended. In working out its details I calculated the probable production of 1906, basing my estimates on capacities of the sugar factories which were expected to be in operation, and assuming a reasonable length of campaign for these factories. I added to the estimated total manufacture of beet sugar the actual production of cane sugar in the South in 1905, assuming that the production for 1906 would be the same. In a similar way I demonstrated that by combining the production of sugar east of the Mississippi River with the surplus of production west we had a total production exceeding by about 23 per cent the consumption of sugar west of the Mississippi River for the year 1900.

In that forecast I estimated the production of beet sugar for the entire United States for 1906 at 1,037,300,000 pounds. The actual returns for 1906 (see p. 104) are 967,224,000, only 70,000,000 pounds, or about 7 per cent, short of the estimate. The estimate would doubtless have been fully realized but for the fact that three of the older factories included did not operate and four of the new factories were late in completion and had light tonnage on account of small acreage planted.

The assumption that the cane-sugar product of Louisiana and Texas in 1906 would equal that of the previous year was somewhat wide of the mark, as the latest estimates of the product for 1906 show it to be only about 71 per cent of the crop of 1905.

SOME IMPORTANT FEATURES AND BENEFITS OF SUGAR-BEET CULTURE.

A few of the important features and benefits of sugar-beet growing deserve special consideration.

WORK OF THE FACTORY AGRICULTURIST.

There are now in the United States 64 beet-sugar factories. Each of these factories has an official known as an agriculturist. It is part of his business to study the problems presented by the climate, soil, and other conditions of his locality. It is his further duty, after arriving at conclusions, to promulgate them and to offer practical suggestions to the farmers interested in growing beets for his factory. As a rule the agriculturist of a factory has from three to a dozen assistants who are well fitted for their work. Directly, and indirectly through these assistants, the agriculturist is in constant communication with the farmers, advising and aiding them and insisting on the employment of right methods. Every farmer growing beets

for the factory is to some extent a pupil of this teacher of agriculture; and, to a considerable degree, the same is true of his neighbors, because they are constant observers of results.

Incidentally this agricultural superintendent of the factory discusses most problems that have to do with the farm because, directly or indirectly, they have some relation to the success of his manufacturing industry. Feeding, breeding, fertilizing, plowing, cultivating, harvesting, irrigating, farm physics, farm business, farm labor, and good roads are all related to the work of the sugar factory. This work of agricultural education kept up indefinitely must produce results of lasting benefit to any community. The farmers must, in the course of time, be greatly benefited, and their children are benefited still more. The lands and farm methods are directly improved. The community constantly rises in the scale of proficiency.

The sugar factory furnishes a thoroughly equipped laboratory, with a chemist and assistants to test the quality of the beets, to analyze the soil, the water, and the crude materials entering into the process of sugar manufacture. The factory management engages extensively in experimentation. It learns the quality of the soil and teaches how to improve it; it tests the quality of the beet seed; it studies meteorological conditions. A sugar factory not only becomes an active ally of the agricultural college, disseminating knowledge and teaching methods, but it also becomes an ally of the State experiment station, discovering new facts by actual experimentation. It provides all the facilities for doing these things, and all the crop producers of the community become the beneficiaries. No one is better advised regarding the potency of the educational work accomplished by the sugar factories than the agricultural colleges and State experiment stations. That they are of great value as aids to agricultural education and investigation is the enthusiastic belief of every agricultural college man in the States where sugar factories are located. The nation and the State pay large sums of money for conducting our agricultural colleges and experiment stations, but in the sugar factories we have an educational agency that is cooperating to a large extent in the work of these institutions without any direct financial aid from State or nation.

Observing these results from year to year, especially in the older districts where such influences have been longer at work and have accomplished most, I am convinced that the educational benefits are worth all that has ever been paid for the sugar factories.

SOIL IMPROVEMENT THROUGH BEET CULTURE.

Our population is increasing very fast, and to sustain it a greater demand is made upon the productiveness of the soil than ever before. Our methods of culture and soil improvement must keep pace

with our growth in population. As our areas per capita grow less, we must intensify our agriculture. By methods of soil improvement we must develop higher productiveness. Germany and France had to meet these conditions years ago. Their necessity required the discovery and application of principles resulting in greater productiveness of the soil. Agriculture was intensified through crop rotation, soil culture, and fertilization. In the beet districts of these countries these roots are grown on land worth from $300 to $800 an acre, and in some instances more. Nevertheless, these countries can produce sugar cheaper than we. The lower cost of labor has something to do with this, but the better and more careful methods of farming have a great deal more. We need to strive for the proficiency acquired by our foreign competitors, not only in the production of sugar beets, but of all crops. The sugar factories are tending in their respective districts to work out this evolution. Gradually, but surely, they are doing away with that style of farming which may be characterized as slipshod, careless, unscientific, and wasteful, and introducing the better methods represented in the beet fields of Germany and France.

The establishment of beet-sugar factories in this country has greatly promoted the investigation of soils. Before a factory is installed in a locality it is a matter of great importance to its financial backers to learn whether such locality has soils with the right properties. The constituent elements as well as the physical properties of the soil must be investigated. It must be assured that the farmer will receive sufficient tonnage and that the factory will receive beets of a suitable quality for sugar making. Some soils are adapted to beets; others are not. This has stimulated soil investigation, and has resulted in large additions to our knowledge of the soil.

BENEFITS TO LIVE-STOCK INDUSTRIES.

In the Mountain States, like Colorado, Montana, Wyoming, and Idaho, stock industry was formerly confined to grazing. Large herds of cattle and flocks of sheep roamed over this short-grass region. While this grass is short it is nutritious, and it has the peculiar quality of curing on the ground. In the States I have named it is possible to graze the year round, with very little protection to stock. The range must connect with a water supply. Often it is possible, without grain feed, under these conditions to put stock at the age of 4 years on the market of Chicago and other places fairly ready for the block. Formerly most of it was shipped into the corn belt farther east and fattened. Such States as Iowa, Kansas, Nebraska, Illinois, and Missouri usually prepared this stock for the market. The development of the sugar industry in these Western range States is rapidly bringing about a change in all this.

The sugar factory brings in the settler, breaking up the range. This is especially the case where it is possible to irrigate.

The pulp and waste molasses, together with the alfalfa hay grown in rotation with beets in these States, together with a little grain, afford an excellent fattening food ration. Most of these States grow barley, wheat, oats, and spelt, which, added to alfalfa and beet pulp, enable the feeders to finish their beef cattle for market considerably better than formerly. The grain requirement is much less than in the old fattening ration. By mixing it with their pulp and alfalfa these feeders can better afford to import corn from the Missouri River and fatten their own stock than to ship their cattle east for fattening, as formerly. For this reason these Western sugar States are rapidly diversifying their stock resources.

While the breaking up of the range has a tendency to reduce the number of stock the preparation of the stock for the market at home materially increases its total value. The stockmen are improving the grade of stock and thus increasing the importance of the industry. The same causes that intensify stock raising in connection with beet production also tend to the production of cheese and butter. The day of the open range on vast tracts is about over.

While stock production has been changing from the simple to the complex in the West, in States farther east like Wisconsin and Michigan sugar production has had a great tendency to amplify and improve the lines of stock industry already established. Wisconsin had accomplished much in dairying before the advent of the sugar factory. In the last two years the State has assumed considerable importance in sugar production. It has now five sugar factories, and, though young in the industry, the effect on the stock industry is very marked.

The State of Michigan, prior to the advent of the sugar industry, had no well-developed stock interests like the State of Wisconsin. In the last few years, however, the benefits of the sugar factory to stock feeding have begun to be realized and appreciated, and the State's progress in stock breeding and feeding gives evidence now of rapid development.

The sugar factory turns out large amounts of by-products adapted to the farmer's use for feeding. He can use this stock food to better advantage than people owning animals in cities and towns. He comes to realize this and naturally increases the animals on his farm. He directs his interests in stock to those lines best adapted to utilizing the by-product food—such as milk production, breeding, and fattening meat animals. He is constantly tending to an increase of animals on his farm to the extent of its natural food-producing capacity. He appreciates the necessity of building up and keeping

up its fertility. Rotation of crops—so necessary in beet growing—has in view the proper rest and reenforcement of the soil. To the barnyard the farmer naturally looks for one of the chief sources of his productive wealth. At the proper time in the cycle of rotation he resorts to effective soil fertilization. He plants his crops in rotation in accordance with the demands of the animals to be sustained. In this connection the by-products of the sugar factory are an important consideration.

INCREASE OF CROP RESOURCES.

One of the noticeable results of the sugar industry is its influence in increasing the crop resources of the various sections of the country. Probably the most noticeable effect of this phase of beet growing is to be observed in Wisconsin. In the country surrounding Madison about 12,000 acres of tobacco has been grown. In Rock County, surrounding Janesville, nearly a like area has been cultivated to tobacco for a number of years. In the necessity for preparing the soil and keeping it up to a high standard of fertility and tilth, and in the expense of doing this, tobacco is a crop more similar to the beet crop than any other. It has taken considerable time and energy to work tobacco growing up to its present status in these two sections. A sugar factory was located in each of these places. One has been in operation for three years and the other only during the last campaign, but both areas have been growing beets for some time to a considerable extent for the factory at Menomonee Falls, farther east in the State. The tobacco interests were very much alarmed at first. There was a tendency on the part of many of the tobacco growers to turn their acreage to beets. In many localities there was a large acreage of the tobacco lands planted to beets. At considerable expense new lands were prepared and cultivated so as to produce a crop of beets. As a natural consequence they were brought to a higher state of tilth than formerly. At the next planting the farmer must put in some other crop in rotation with beets. After he has grown a crop of beets he finds his land in admirable condition for tobacco.

During the four or five years beet growing has been in operation among the tobacco fields of Wisconsin this has proved the natural tendency. The beet-sugar industry has introduced tobacco growing into a larger field than it had before. It has become more profitable to grow tobacco on account of the relation of the two crops. A similar condition prevails in some parts of Colorado. Lands producing potatoes profitably for a long while must be changed to some other crop and rested. They are naturally in fine condition for beet growing, which is therefore introduced, and the beet crop leaves the land again in a great deal better shape for potatoes. It is found in those

irrigated States that they have more lands to grow alfalfa, potatoes, melons, wheat, and other cereals, from the fact that the sugar factory, on account of its superior capitalization, has increased the facilities, including labor, irrigation, rotation, and trolley and railroad lines for shipping.

The beet-sugar industry not only increases established crop production, but introduces new crops adapted to the conditions, especially of our newer sections of the country now developing. The United States Department of Agriculture has in recent years investigated agricultural conditions and crops in different parts of the earth, and has introduced into our own country valuable plants adapted to like conditions here. The beet-sugar interests have been responsive to this work, grasping the advantages and applying discoveries beneficial to this industry.

IMPROVEMENT OF THE SUGAR BEET.

From the inception of the manufacture of sugar from beets there has been a constant struggle for supremacy between the cane-sugar interests of the Tropics and those producing sugar from beets in the Temperate Zone. At the present time they are pretty evenly balanced in this contest. According to Willett & Gray, the world's production of sugar for the last year amounted to 14,305,823 long tons. Of this, 7,144,377 tons were credited to beets and 7,161,446 tons to cane.

From a plant yielding from 6 to 7 per cent of its weight in sugar, the sugar beet has been improved so that it will yield from 15 to 20 per cent, some individual beets going as high as 25 per cent. There is a marked tendency throughout the beet-growing districts of the United States year by year to increase the general average of sugar contents. The custom of holding prize contests has encouraged the production of better beets. These contests are conducted by county and State fairs, sectional and national expositions, and business and trade organizations. The important points on which the beets are scored in these contests are sugar content, yield, shape, cost of production, time of planting and harvesting.

The sugar content and purity of the beets are of the highest importance to the factory. If the purity is high, the expense of manufacture is considerably less. In many of our factories beets are bought on a sliding scale, or according to the sugar content and purity. In such cases the farmer benefits with the factory in the higher percentage of sugar and purity in the beet. In many other cases the farmer is paid a flat price per ton. Even in such cases he benefits indirectly by the higher sugar contents, because the factory can afford to pay more for beets if they are of better quality.

The tonnage of beets is the point that more particularly interests the farmer. It governs to a large extent his profit in growing the crop. Large tonnage benefits the factory indirectly, because it increases the amount of raw material to be used in the manufacture of sugar. The success of the factory each year is dependent largely upon the amount of beets it receives.

The shape of a beet has considerable to do with its merit. An ideal beet should be long and gradually tapering. That part of the beet next to the crown is not of nearly so high a quality as the rest. The shape of the beet is influenced by the nature of the soil, methods of cultivation, and its inherent tendencies. If a beet is bunchy, a greater portion of its rootlets are ramifying through the soil near the surface, more liable to be disturbed by cultivation and not performing so readily the important functions for which they are intended.

The cost of production is largely relative, depending upon the yield, the cultivation, fertilization, etc. The yield may be influenced largely by the inherent tendencies of the plant and especially the quality of the seed.

Seed production involves selection and breeding. If the proper methods have not been followed in producing it, there is a marked tendency toward reversion to poorer form and quality. The plant breeder aims to hold up the sugar content of the beet and at the same time to produce seed of higher vitality.

An important point in producing a crop of beets is to secure a stand. In order to secure a good stand it is necessary to plant many more seeds than are expected to grow beets. The higher the vitality the higher the germinating power of the seeds and at the same time the stronger the plantlets in resisting the obstacles with which they have to contend during their early stage of growth. Upon these things depend the stand and to a large extent the final yield. From the increase of yield there is more to be anticipated in the future development of the beet-sugar industry than from any other feature. Nowhere have we approached in any single instance the ideal yield, which has been calculated at about 43 tons per acre. I think the largest yield in any single case of a tract containing 10 acres or more was about three-fourths of the ideal, or about 33 tons per acre. Half of the ideal yield has been secured in a great many instances. In fact, there is hardly a district in the United States producing beets in which a few farmers do not secure 21½ tons. It is a matter of congratulation to note that in all of the older factory districts the average yield has grown considerably, and it is constantly on the increase. In recent years we have been building so many new factories, and consequently introducing the cultivation of sugar beets into so many new districts, that these higher averages of established beet-growing districts have been kept down to a general level of 8

to 10 tons. However, the tendency to higher tonnage after a district has grown beets for a while is a fact kept well in mind by those best posted on the progress of the industry. It is also kept in mind that to the scientific plant breeder must we look for increased yields in the future.

The time of planting and time of harvest are also important points as bearing upon the quality of the beet, these depending very largely upon the conditions and circumstances of the season and place. They also depend to a considerable extent upon the qualities of the seed, and are therefore matters of concern to the plant breeder. Conditions of place and season are matters that are fixed to a greater or less extent. Beets must be brought into adjustment with the conditions.

To the plant breeder are we looking for a higher sugar content and purity of the beet; for a higher yield and a better adaptation of the plant to its environment; for a higher vitality of the seed and of the plantlets, and for beets that will conform more nearly to the ideal in shape. This field of effort is now well and ably occupied. There is no other field crop or product of our soil that has received so much consideration and actual scientific investigation as the sugar beet.

One of the most important problems now occupying the attention of plant breeders is that of developing a strain of beets whose seed balls will contain but a single germ instead of several, as is the case with the ordinary beet. Each germ in the ball is likely to produce a plantlet, in which case the plantlets may intertwine, forming a tangled bunch. As all but one must be extracted from the soil, the one remaining must necessarily be disturbed and injured. The thinning process is one that must be performed by hand, and it can readily be seen that the expense is considerable. If the beet ball had only a single germ, much of the expense and trouble of thinning would be done away with.

The problem of producing the single-germ beet ball was taken up by the Bureau of Plant Industry of the United States Department of Agriculture four years ago. Annual reports on the work indicate that good progress has been made.

IRRIGATION AND SUGAR-BEET GROWING.

The influence of the beet-sugar industry on the development of irrigation is very marked in the newly developed agricultural sections of Colorado, Idaho, Montana, and Wyoming. From the beginning Utah, which was dependent upon its irrigating canals, projected extensive systems for watering the soil in order to produce ordinary crops. The same may be said to some extent of California. How-

ever, even in these States the sugar factory has had much influence in promoting irrigation improvement.

Colorado is the real reflector of the strength and power of sugar production as influencing active development of irrigation and the various productive interests based upon it. Fifteen years ago irrigation in this State was of the most primitive character. Its great, towering, snow-capped mountains and deep-cut valleys were not thought of as storehouses of wealth dedicated to agriculture. The water from the melting snows went leaping down its gorges and canyons and was carried away by the rivers. Agriculturally a stream of water was principally valuable for watering the grazing stock. The State was known to be rich in its mineral wealth, and attracted population and capital for investment almost solely for this reason. Its agricultural interests were slight in comparison. In recent years these have developed with gigantic strides. They very much exceed the mineral production of the State at the present time. In 1905 the production of sugar from beets alone in that State was very nearly equal in value to the silver production, and the output of sugar in 1906 leaves it far behind. The increase in this product has been phenomenal. Its estimated value in 1899 was $100,000; in 1906, $15,000,000. Ten years ago its irrigation systems were but poorly equipped and inconsiderable in extent. At the present time Colorado has many thousands of miles of main irrigating canals, connecting with a still greater mileage of laterals, and other large systems are under construction or in contemplation. At the beginning of the sugar industry these canals were principally ditches dug in the earth conveying water taken from the streams at various points. The system was poorly engineered and wasteful, resulting in a large percentage of loss due to seepage and to lack of frugal management. The few reservoirs in existence were mostly of similar character. The laws of the State regarding irrigation and the rights of the people to use water were as haphazard and indefinite as the system of irrigation itself. The legislature of the State has passed better laws defining and protecting these rights and more nearly placing the irrigating ditches under the proper regulations; and under the inspiration of the example set by the United States Government in its reclamation work the ditches and reservoirs now projected in the State are of the most substantial character. The wasting waters from the Rockies are being impounded in immense reservoirs of concrete construction, the overflow being caught up again by other reservoirs of similar character, with the mains constructed in the most durable manner of concrete and stone, and under the best of engineering skill.

In Colorado can be found some of the best systems of irrigation devisable by modern engineering talent, equal to the best constructed

anywhere else in the world. They are so built that they will withstand the destructive effects of the elements for ages, under a plan combining the control with the use and proprietorship of the land.

In 1899 Colorado had one small sugar factory; in 1906 it had in operation 15. Not only has the capacity of the original factory been doubled, but those built since have from two to four times the capacity of the original one. They are scattered along these irrigating ditches and are supplied with raw material from the farm lands brought into production by means of the water facilities thus afforded. There is hardly an irrigation system in Colorado of any importance which does not furnish water for growing beets for one or more of these factories. The building of recent ditches has generally followed the maturing of plans for constructing sugar factories.

What has taken place in Colorado is being rapidly duplicated in Idaho; a beginning has been made in Montana, and the time is surely approaching when a commencement will be made in Wyoming. Throughout these States natural conditions are quite similar; consequently they parallel each other closely in the development of crop resources. Rotation is the keystone of the scheme of agriculture in these developing States. Its importance is insinuating itself into the minds of agriculturists more rapidly than in those of our better-settled States of the East. This is due to the more limited crop resources of the West, the important ones being the root crops, represented by sugar beets and potatoes, in the order named, and the small grains—principally wheat, oats, and barley. Throughout the length and breadth of the arable territory in these States alfalfa is the principle legume. All of these crops yield abundantly. They are adapted for use in a rotation cycle. On account of the value of the sugar industry as a means for the promotion of organization and the attraction of capital, sugar beets have become a very important factor in the working plans.

In the West, to which irrigation is mostly confined, public-spirited business men have formed organizations devoted to the consideration of the best means and methods of the use of water. Associations, local, municipal, county, and State, devote much time to acquiring and distributing information pertaining to irrigation and the development which it induces. Whether the assemblage be temporary or permanent, the exposition feature is usually prominent. Usually a prize is offered for the best farm products grown under irrigation. These prizes are generally of considerable value, and excite enthusiastic contests.

With the progress of irrigation new sources of water supply are constantly being utilized. Irrigation was first effected from running streams. The limit of the supply of water was that furnished by the

flowing streams during the growing season. Later impounding the early flow and surplusage in reservoirs was resorted to.

In many parts of the country it was found that flowing artesian wells could be secured by penetrating the earth to lower strata. Many tracts of fertile lands not susceptible to irrigation from streams on account of location are now being supplied in this way. Other flowing wells are developed near the streams. Their waters are conducted into them and therefrom into the irrigating ditches, increasing the suply of running water.

It has been discovered that throughout the length and breadth of the irrigation sections following the rivers are immense amounts of sheet water and subcurrents, fed from drainage from higher lands, seepage from streams and irrigation ditches, and the final wastes from them. Recent developments of irrigation include the effort to secure these waters for use in irrigation. This is accomplished by pumping; sometimes by a single individual for a small tract of land, at other times by a company or a large corporation for the irrigation of larger tracts. For the purpose of the smaller undertaking the gasoline engine is found feasible and practicable. It is even found in many instances that irrigation can be effected in this way at a less cost than through the other methods. Where larger tracts of land are to be irrigated engines of high power are required, and these can be propelled by cheap fuels so abundantly distributed throughout the West in the form of wood, lignite or other varieties of coal, natural gas, and fuel oil. After many experiments, so practical has this system of irrigation appeared that the Government in its reclamation work is devoting large sums of money to the development of irrigation by pumping systems. In a paper written by F. H. Newell, of the United States Reclamation Service, we are informed that the most economical well for pumping purposes is one from 12 to 15 inches in diameter, penetrating to water-bearing gravels 30 to 60 feet in depth. In this paper he gives some of the items of cost, and for general information I quote a section of his paper, as follows:

A popular source of power for small pumping plants is the gasoline engine. Where the price of gasoline is high it is very easy to make the cost of water prohibitive by the use of such power. Whether or not it pays to pump water by gasoline is a matter which depends very largely upon the distance the water must be lifted and also upon the kind of crop that is to be irrigated. Gasoline, even at a high price, is usually a cheaper fuel than coal in an ordinary steam engine of small horsepower, such as a common traction engine. For plants requiring from 20 to 30 horsepower, producer gas generators can be installed which will keep the cost of pumping down to a minimum. A suction gas producer using anthracite pea coal for fuel should furnish power at the rate of 1 horsepower per hour for each pound and a half of coal consumed. At $8 per ton the cost of coal should be equivalent to gasoline at 4 to 6 cents per gallon.

It is very unlikely that it will pay to pump water under present conditions in the valleys of the western plains to a total height of more than 30 feet, includ-

ing the suction lift of the pump. If the pump lowers the water in the wells 10 feet, and if the distance to water be 10 feet below the ground, and the discharge pipe be brought into a reservoir or flume 5 feet above the surface of the ground, the total lift will be 30 feet, if 5 feet be added to cover loss of head due to friction in suction and discharge pipe.

In order to irrigate economically from pumping plants it is usually desirable to pump the water into a reservoir having a capacity equal to the amount of water the plant can furnish in six to eight hours. Such a reservoir is absolutely necessary for best results with small pumping plants. If the supply of water exceeds 500 gallons per minute, it is possible to dispense with the reservoir, especially if the supply greatly exceeds this amount. Plants furnishing over 1,000 gallons per minute can usually be best operated without the use of a reservoir.

PROMOTING THE SUGAR INDUSTRY.

To keep pace with the developments incident to the progress of the beet-sugar industry in the United States, my work must necessarily change somewhat. Originally the public desired information as to the adaptability of soil and local conditions. Now sugar factories have become so widely scattered throughout the beet-growing area that these conditions have largely been determined. Without much trouble or travel farmers themselves can go into the beet fields and study the methods of culture and the results of growing beets on the different soils. At present the thing most desired, where conditions are favorable and the soil is adapted, is information as to the best methods of securing the introduction of the sugar factory. A large part of my correspondence, conversation, and public efforts is to educate the people how to become directly and actively participants in the sugar industry. Nearly every locality in a beet-sugar district possesses the ambition to have a sugar factory of its own. I shall devote a short chapter along the lines of consummating this laudable ambition.

WORKING UP LOCAL INTEREST.

The first effort should be directed toward arousing a local interest. This should not only consist in a desire to secure a plant, but in a knowledge of local advantages and conditions. To attain this knowledge organization must be effective and earnest. The community seeks the introduction of an industry affecting not only its agriculture, but its general business interests. It is a direct or indirect benefit to everybody. Successful effort requires the cooperation and activity of all interests. The capitalization of an ordinary sugar plant is about $500,000. The bulk of the money received from its output of sugar is paid out in the local district for the beets, labor, and crude material necessary in its operation. With a successful plant, for beets alone the farmers of a tributary area will receive at least $250,000 annually; for labor in the factory, fuel, and other

crude materials the factory will expend over $50,000 more—that is to say, three-fifths of its original investment is distributed each year to the business, farming, and laboring people in this area. Everyone interested in the community's progress should thoroughly appreciate this and should work accordingly.

BEET-GROWING EXPERIMENTS.

The first fact of interest to a sugar-factory capitalist investigating such conditions is the probabilities of beet growing. He desires to know the quality of the beets and the probable yield. This knowledge can only be acquired by tests. These tests must be thorough and under approved methods. Considerable guessing was done in the early establishment of sugar factories, but those days are over. People in a locality desiring a plant now must be prepared to furnish the detailed facts and complete information. The best way to accomplish this is by organizing all interests in the community into an effective association for promotion and experimental purposes. The most convincing experiments are those that yield practical results. This association should arrange with the management of some operating sugar factory, if practicable, and contract to furnish it a definite acreage of beets. This should be done if the receipts from the beets only pay the expense of production and delivering. They should be grown under the regular supervision of the factory management, according to approved methods. Exact data should be secured as to tonnage, sugar contents, and purity of the beets; as to the character of the seasons and other conditions involved. If arrangements can not be made with such a factory, then suitable plats should be selected and planted experimentally. These beets should be grown according to approved methods and under the direction of some one thoroughly versed in beet growing. Possibly the beets will have to be sold to local stock feeders for less than the cost of production. It costs something to find out things. If the community is in earnest, the resulting information is worth it.

Whatever the method adopted to test local conditions, it is generally necessary for this association to raise sufficient funds to capitalize the experiment and to defray the expenses of working it out. Very few factories are built now in localities not thoroughly tested for beet growing. In most instances the tests consist in growing sugar beets for some near-by factory until the enterprise has grown to a sufficient extent to sustain one locally. If the community has not had this experience, then nothing short of a practical, well-directed and governed experiment will satisfy the investor in sugar manufacture. As an illustration of the insistence on this point, I will mention the facts leading to the building of several factories in the various parts of the country during the past year.

One of 350 tons capacity was built at Visalia, Cal., largely upon experimental information, but this had covered a series of years. Some beets had been grown at different times for distant factories. Another was built at Hamilton, Glenn County, Cal., of 1,000 tons capacity, after thorough experimentation such as I have outlined. The same is true of the factory built at Glendale, Ariz., which is a plant of 800 tons capacity.

One was built at Billings, Mont., of 1,200 tons capacity, after years of most thorough experimentation throughout the valleys tributary to this point. Not only was experimentation and promotion carried on at considerable expense, but an association had been active for a period of several years working to this particular end.

A factory was built at Nampa, Idaho, of 750 tons capacity, after complete experimentation and practical growing of beets for delivery to factories in eastern Idaho and in Utah.

A factory was built at Brush, Colo., of 750 tons capacity. Several hundred acres of beets had been produced in this community during several seasons. The same is true of Fort Morgan, Colo., which established this year a plant of 600 tons capacity. Swink, Colo., which is near two sugar factories, established a factory this year with a capacity of 1,200 tons. This community has been growing for several years a large acreage of beets.

A factory of 600 tons was completed at Charlevoix, Mich., which had been several years building, and every year has been growing a considerable acreage of beets and disposing of the same to other factories in that State.

It must be evident that information bearing upon beet production must be of no haphazard or indefinite character. The factories built last year went into districts almost as thoroughly tested as the older factory districts. There are a great many other districts for which the necessary data have been accumulated, which are yet without factories, but seeking them. Quite a number will secure them during the coming year. It must be understood that no community with ill-defined or poorly ascertained facts at to its conditions for beet growing has any sort of opportunity against such communities as I have just described.

CONCESSIONS TO PROMOTE FACTORY BUILDING.

Under this head it is not my aim to suggest the proper course, but simply to relate what is done either occasionally or ordinarily. In closing the details the factory builder often requires a donation of a certain acreage for a site. He may require of local capital a definite subscription to the stock of the company. From the transportation companies he may ask a specific and low freight rate covering his raw products and supplies, certain switches and side tracks at the

factory, and country dumps for loading beets at some distance from the factory. The local authorities may be asked to rebate taxes or not to assess the plant for a definite number of years; a demand may be made that water be furnished the factory for a certain stipulation or free for a time; that sewage connections be made with the factory, and possibly that indemnification be guaranteed against damage to streams due to factory drainage. There are many things that he can ask and does ask. All these things suggest the necessity for an active committee or association or some central head to arrive at definite conclusions and settle the preliminaries.

CONTRACTS WITH FARMERS TO GROW BEETS.

A sugar-factory investor will not only insist on ascertaining that beets of the right quality and quantity can be grown in the community, but he must have the assurance that if a factory is built they will be grown. Before builders of plants will close an arrangement for their installation they must be furnished sufficient contracts with the farmers to assure a complete supply of beets. These contracts may be for one or two years or sometimes as high as five years. The local association must be ready to furnish this contracted area before it can hope to establish a sugar factory.

No one can appreciate, unless it is a local committee or the managers of a factory who have gone through the ordeal, the trouble, delay, and disappointment incident to securing contracts with the farmers. The farmer is naturally conservative. With the ordinary farmer the necessary routine of the farm is not one developing a wide experience in business affairs. A community may be apparently thoroughly aroused, all its business interests in sympathy, and seemingly everyone in perfect accord regarding the desirability of locating a sugar factory. Only when the contract is presented to the farmer does the actual difficulty become apparent. He is engaging to do certain specific things for a definite time. He wants to know all about them. No matter what the public instruction has been, the matter must be gone over thoroughly with each farmer. He must have time to talk it over and think over it. He wants to ask questions. He will think of different questions, according to his peculiar temperament. In securing 5,000 acres of land, 1,000 to 3,000 farmers must furnish the contracts. As a rule this involves meeting and satisfying many different temperaments. While all this requires the most patient, painstaking, and careful industry, the farmer is acting from correct principles. You are introducing a new thing, entirely outside of his experience, which has not been sufficient to enable him to act on this specific thing. I desire to suggest that it is the absolute duty of those taking upon themselves the arduous task of securing these contracts

to prepare themselves for the ordeal. If the reader, who may be interested in such an enterprise, could see and know, as I have, the number of deserving projects that have fallen down for lack of proper method and detailed information on the part of their promoters, he would appreciate the importance of this suggestion. The farmer should be instructed as to the benefits. Too often in securing these contracts men are sent out who are poorly advised as to the real merits of the case. I recall an instance where it was thought advisable to use for this purpose a lot of local fire-insurance agents, simply because they were known to be good talkers. Whoever is selected for this work should know the benefits this industry carries to the farmer and to the community. It is a simple story, but a logical one. Like everyone else, before he acts he has a right to know where his interests lie, the same as if he were buying land, stock, dry goods, insurance, or anything else. No one would think of selling any of these without being able to present its merits.

POINTS THAT APPEAL TO THE FARMER.

There are a few points that always appeal to the farmer. The sugar-beet crop is one that does not fluctuate in price. He knows in the beginning what he is to receive per ton. He is not subject to the hazard of a falling market when he sells his crop. In fact, it is sold before he produces it and at a price satisfactory to him.

Most farmers are aware that there is a general tendency to deterioration of their soils from constant cropping. Any crop which gives the land a chance to recuperate appeals to them. The thorough stirring of the soil and superior tilth and general cleaning up of the land used in growing sugar beets, the necessity of fertilization, and the ability of the crop to carry the expense are things that he will consider.

He may hesitate on account of the scarcity of labor. When he appreciates that the sugar factory represents an organization especially adapted to, and interested in, securing labor, and bringing it in by carloads, he feels better satisfied.

He usually hesitates on account of the extraordinary expense involved in growing sugar beets. He must be impressed with the greatly superior net profits of this crop over others. He can be given tangible evidence showing actual results of farmers in other parts of the country, or general averages of a whole neighborhood growing sugar beets. At the same time he can be convinced of the general rise in land values and the high rentals paid for land growing beets; both of which, as a rule, double and sometimes treble after the sugar factory has been in operation long enough to demonstrate its usefulness.

It is always good policy, where possible, to take excursions of farmers from such districts into districts actually growing beets for a sugar factory. Let them mingle with such farmers and gain from them the facts of their own experience as to the benefits. Let them see a sugar factory in operation.

Many farmers will object to the nature of the labor in connection with sugar-beet growing. Thinning and weeding by hand while on one's knees is not a work or a posture agreeable to the average American farmer. Bending over the rows and crawling along them on one's hands and knees all day long are things that the contracting farmer is sure to object to as drudgery. It is an arduous job, and the point must be met and explained on its own merits. Our farmers ride on their stirring plows, cultivators, and many other implements. Naturally they do not look with much favor upon any crop that tends to deviate from this system. The tendency of modern farming is away from its drudgeries rather than toward increasing them; it is also toward a greater independence of the farmer. As a rule our lands are farmed by the owner. We differ in this respect from the European beet growers. Beets are grown in those countries under a system of tenantry.

In the original consideration of this subject of beet growing most farmers assume that they must do this work themselves. We are making inventions and devices for the purpose of eliminating as much as possible the hard work and hand labor. But ordinarily a farmer must expect that there will be a good deal of hand work. It is only in the intensified crops that he is justified in investing capital in labor to any considerable extent. Beet production costs about $30 an acre in those States where sugar beets are grown under rain conditions, and about $40 an acre in States under irrigation. Most of this cost is for labor. It is not at all necessary that the farmer should do any of this hand labor himself. The sugar-beet crop is one that will pay for its own labor cost. The farmer can plan to do by himself and his farm hands the actual team work, which is very similar to that necessary with other crops. The land must be plowed and harrowed, and the crop must be given usually from three to five cultivations. In the harvest the beets must finally be plowed out. The hand work is a feature entirely distinct from this. There is a class of labor accustomed to and inclined to do this hand work. They take it in preference to any other kind of work. As a rule they have been reared to do it. It is the work they know the most about, and apparently the one they desire most to do. They have become inured to it. It is a calling with them. The beet-growing farmer can usually contract for all the hand work, which includes bunching and thinning of the beets, hand hoeing, hand weeding, and the hand work of harvesting after the beets are pulled. This hand work of harvest-

ing consists in lifting the beets from the soil after they are loosened, bumping them together to jar loose the adhering dirt, clipping off the tops with a sharp knife, throwing them in piles, and finally loading them into wagons to be delivered to the factory. The prevailing cost under contract for this hand labor in the sugar-beet fields is about $20 per acre. The estimated cost to the farmer for his team work, seed, etc., in growing beets under rain conditions is about $10, making a total of $30 per acre. In the irrigated districts about $10 is the estimated cost of water and putting it on the soil through irrigation, making the actual cost about $40.

To the farmer who objects to the nature of this hand work it is only necessary to explain that the beet crop will take care of the cost and that the sugar factory attracts the laborer to do the work; if necessary, secures it for him.

Now, when the farmer has been advised of the direct benefits of the sugar-beet crop—a sure and stable market, soil improvement, availability of labor and ability to hire the same, and increased land and rental values—he must be enlightened on a list of incidental benefits. He should appreciate the favorable influence beet culture has on his farm and general farm products. The deep plowing necessitated in the preparation of the seed bed, the stirring it receives during its several cultivations and harrowings, and the plowing again at harvesting thoroughly loosen and pulverize the soil. The fact that it is kept entirely clean and free from grass and weeds makes it a better producer of any other crop that may be planted upon it. This effect is to be felt for several years and very much adds to the productive power and future utility of the land.

The benefits do not stop with the crops; they are felt in stock production as well. No farmer can begin to appreciate, until he has experience, the value of molasses and sugar-beet pulp—by-products of the sugar factory—as a food for stock. Of these every sugar factory is turning out at least half the original weight of the beets. Pulp is immediately available for the farmer's use; it is easily stored and kept; as a rule, it is considerably cheaper than any other feed he can buy or produce. Usually this pulp can be purchased at the factory for 35 cents to $1 per ton. Such low prices must necessarily continue for some time.

To appreciate the use and benefits of these by-products requires time. This is the usual experience of every sugar factory. In delivering beets the farmer can take home a load of pulp, making the cost of delivery very slight. Our State experiment stations in those States in which sugar factories are operating have been conducting exhaustive experiments to demonstrate the value of this pulp compared with other kinds of food. According to the purpose of feeding, the animal fed, and the local cost of various feeds, fresh pulp

varies in actual value as a feed from $1.50 to $2.50 per ton. As a rule, in disposing of this pulp factories give their beet producers advantages over competitors. This is always true where committees have developed considerable competition in securing it.

The benefit to the animal eating pulp is of two kinds—nutritive and sanitary. Where feeding is considerable and pulp is used as one of the main ingredients of the food ration stockmen insist that its sanitary effect is of vital importance. It is generally desirable for hogs, sheep, cattle, and horses, and especially valuable in milk and meat production and for breeding animals. Especial attention is called to this fact. In the fattening ration we are inclined to use too much condensed hot feeds; this leads to stomach and intestinal disturbances; mixing pulp with these feeds corrects these disturbances, promoting the animal's health and a tendency to lay on fat and choicer, juicier flesh.

One of the leading concerns of every farmer is good roads. A farm rightly conducted is of little avail unless it is possible to connect it with the market or the transportation lines by means of good roads. Good roads in a farming community are a prime necessity of every sugar factory. Nothing in a community redounds so much to the interest and benefit of a farm. On account of its insistence on road improvement, if for no other reason, the factory is of prime importance to the farmer.

In the sugar-factory districts throughout the country many other industrial enterprises follow the establishment of factories. While they are not parts of the plant, they are natural adjuncts. They are institutions helpful to the farmer's interests, demanding his products, intensifying the local market for them, and broadening his field of operations. The development of facilities and subsidiary industries expands and matures the agricultural status of the community and increases the acreage capable of more extensive and intensive farm husbandry. Among the industries that often follow the establishment of the beet-sugar industry are creameries, cheese factories, and canneries devoted to the preparation of foodstuffs, such as canned corn, tomatoes, peas, beans, and fruit; also picking establishments and the like.

A sugar factory in a farming district is sufficient guaranty of good roads, railroad transportation facilities (both trolley and steam), rural telephone lines, the best methods of intensive farming, and such appliances and implements as are best adapted to profitable production. These all work for the betterment of the farmer's status and for higher values of his products and his farm. All this is capable of demonstration to anyone giving careful investigation. These are matters of which the farmer should be advised when he is asked to sign a contract for the production of beets for the sugar factory.

In promoting a project for building a sugar factory, not only is the farmer brought into working sympathy and given an understanding of his interests, but unison of action on the part of the business interests is promoted. Every business conducted in a sugar-factory town is made to feel its helpfulness. As a rule, these factories go to the smaller towns and villages rather than to our important cities. Rather than incur the expense of taking the raw product to a large city, the sugar manufacturer finds it more practicable to take the factory to the raw product. For beets and other necessities required in manufacturing sugar a factory annually pays out several hundred thousand dollars in the community where it is located. This materially increases the local per capita circulation. This money is used in local business and increases the prosperity of the whole community.

WORK OF THE PRESS.

The newspapers are a strong factor in disseminating information regarding the beet-sugar industry. It should be the aim at all times to give the public plain, uncolored facts. There is a tendency in promoting a sugar-factory project to highly color everything pertaining thereto. Often the cost of production is understated, the profits are magnified, and the laborious work for the farmer is concealed. All of these should be stated frankly and openly in the beginning. A new industry as complex as this, before it can be declared a success, has many obstacles to meet and problems to work out. It takes two or three years to get the working machinery of the whole scheme into most successful operation. In order to gain that confidence and patient cooperation which is necessary for bringing the enterprise to a successful issue the statements made should be conservative.

NEW FEATURES RELATING TO FACTORY OPERATION.

Improvements in all matters affecting the beet-sugar industry are constantly being introduced. From the inception of the manufacture of beet sugar in Germany and France and more recently in our own country there have been constant improvements and experiments tending to a better status from year to year.

DRYING BEETS.

From time to time in the European beet-sugar countries, and to some extent in our own, experiments have been conducted with a view to changing somewhat the physical character of the beet before it enters the factory to be used in the manufacture of sugar. The aim of these experiments has been to make extraction of the sugar easier and cheaper. Some beet-sugar manufacturers believe if the

beets could be dried before extracting the sugar several advantages would be gained. At least 80 per cent of a sugar beet is water. The first thing necessary in manufacturing sugar from the juice of the beet is to eliminate this water by evaporation. Dried beets could be more easily stored, would require less room, and would not be subject to injury from freezing, fermentation, and other influences which induce chemical changes, inversions of sugar, etc. The length of a factory campaign under such conditions would be greatly extended. A factory could dry enough beets during the time now devoted to an ordinary campaign to run it the rest of the year. It is probable, however, that such a factory would begin manufacturing sugar as at present, while its substations would be drying beets for its later operations.

It is plain to be seen that such a factory could consume a much larger tonnage annually; it could employ its working force and machinery more economically on account of this extension. It could eliminate to a considerable extent the hazards from freezing and thawing of beets and the losses due to chemical action from different causes. The cost of transporting raw material would be lessened. The energy required for evaporation would be directly applied, and much more economically.

Most of the experiments directed to testing the availability of drying processes have indicated favorable results. They have not, however, been conducted on a scale sufficiently large to give reliable information as to comparative costs of the dry and green processes, or as to the possible deteriorating effect of the drying process on the quality of the sugar in the beets.

Mr. George W. McMullen, of Chicago, appreciating the value of such a process to the sugar industry, has been conducting experiments of more than usual extent with this end in view. He has invented a process for drying beet cossettes. I condense a few of the important points presented by him in a report he has made on the subject to the American Sugar Industry and Beet Sugar Gazette.

To an extent his experiments have deviated from earlier ones, since he would first slice the beets, as is now generally done in the factories, drying the cossettes instead of the whole beet. His plan is to erect substations in various parts of the beet-growing area, giving each a total capacity of about 10,000 tons per campaign, or 100 to 150 tons daily. At these substations the beets would be washed and sliced, and the slices, or cossettes, would be passed through the drying kiln, eliminating their moisture. He has conducted these experiments through two campaigns in connection with the management of the Menominee River Sugar Company, at Menominee, Mich. He is associated in his experiments with Mr. Z. G. Simmons. Both are in-

terested in the lumber business and have large kilns for drying lumber. In these kilns have been tested the drying of beet cossettes. This was done at a temperature of about 155° F. The beets used in the experiment were of a high grade, analyzing before the test 16.2 per cent of sugar, and showing 87.6 purity. After the cossettes were dried the sugar contents remained the same, and the purity was increased to 88.6. Tests were made in the diffusion batteries to compare the ease of extracting the sugar from these dry cossettes with those of green cossettes, under equal temperature and with an equal number of cells. It is claimed that the juices in eight cells of the dry cossettes were extracted as fully as those in ten of the fresh cossettes. He claims from this a saving of 20 per cent in the quantity of water used for diffusion, which, in a thousand-ton plant like the one at Menominee, would be equivalent to a saving of $60 per day. His plans for a plant of this size would be as follows: There would be an expenditure of $500,000 for drying plants, in addition to the $1,000,000 for the sugar factory. Such a factory could be operated the year round, having a campaign five times the length of the usual campaign at Menominee. This would virtually multiply the capacity of the plant by five, or increase it from 60,000 tons of beets to 300,000. This investment of $1,500,000 would accomplish as much work as a plant or plants now requiring an investment of $5,000,000. He calls attention to the economies and advantages in labor, freights, markets, etc., of a factory working all the year. He gives an estimate of the saving of expenses as follows:

> At Menominee they evaporate water at an estimated fuel cost of 23½ cents per ton, 1,200 tons daily, or $280 cost of coal. This cost is approximately correct for all the Northwestern sugar plants. The average freight on beets is about 70 cents per ton from the grower to the factory. The water can be taken from the beets at a fuel cost of less than 25 cents per ton, and the other expense at the drying plant would not bring the total cost as high as the freight saved on the water itself.

He calls attention to the saving of insurance, interest, etc., on the difference, $3,500,000, in the investment in the two plants. The process would redound very much to the benefit of the farmer. The drying plants would be located near the beet fields, making a shorter haul by wagon. On account of the very much increased slicing capacity of the factory, all beets could be delivered as soon as ripe.

The results of the experiments made by the inventor become all the more interesting in view of the fact that Mr. Treskow, the technical superintendent of the factory, participated in them.

In order to procure directly from the Menominee factory management information bearing on this work, I wrote Mr. W. G. McCormick, the manager. Below will be found his reply, accompanied by

correspondence between himself and Mr. McMullen, giving his opinion and the results of the factory's part in the experiment:

MENOMINEE, MICH., *January 8, 1907.*

DEAR SIR: I take pleasure in replying to your favor of the 20th ultimo relative to the experiments made with dried beets.

Probably the best way to answer your question is to inclose the correspondence between myself and Mr. McMullen, the inventor of the drying process, in connection with this work.

In the clipping sent they have made an error in the statement as to the cost of the erection of a plant large enough to do this work in a practical manner. It is my opinion that such a plant would cost about $25,000 if made large enough to handle about 300 tons of beets per day.

It is my opinion that this drying process can be put into practical use; and if it were done, I feel quite certain, as stated in my letter to Mr. McMullen, that it would revolutionize the beet-sugar industry, because it would enable one main factory to do the work of five or six and at the same time make a very considerable saving in maintaining the sugar in the beet in its integrity as it comes from the field. I am very certain that the loss by deterioration resulting from handling the crop as is now done is very much greater than most beet-sugar manufacturers realize.

Sincerely, yours, G. W. MCCORMICK.

CHICAGO, ILL., *March 13, 1906.*

Mr. G. W. MCCORMICK,
Manager of Menominee River Sugar Company,
Menominee, Mich.

DEAR SIR: As Mr. Cook, vice-president, and yourself visited Simmons, Mich., and examined my system of evaporation, and you have since that visit carefully followed the various tests made with dried cossettes at your works under your own direction, I take the liberty of asking your replies to the following questions, which I have endeavored so to frame that your answers will convey to beet-sugar manufacturers a definite idea of the scope of my invention:

1. Is not my system of evaporation, as you have observed, plainly in accordance with natural laws and so designed that the products treated can be freed from water without disturbing the chemical relations of the ingredients to each other?

2. Do not the tests show that the sugar properties in the sugar beets are fully preserved; and, further, that, after a considerable interval, there is no deterioration or loss of sugar in the dried cossettes; and would it not therefore be possible for factories to accumulate in the fall, by drying, a sufficiently large quantity of beets to enable them to operate practically the year round instead of a few months, as is now done?

3. Would not the heavy loss of sugar incident to deterioration from freezing and thawing of beets in changeable northern climates be obviated if the beets supplied should be dried and preserved in perfect condition immediately after harvesting?

4. Do not your laboratory tests demonstrate that the sugar can be as quickly diffused from the dried cossettes as from fresh beets and with much less water, and in consequence may not considerable saving be effected in daily evaporation?

I shall be much gratified to receive your replies to the above and such further expressions of your practical views as will put the matter plainly before the beet-sugar manufacturers.

Very respectfully, yours, G. W. McMULLEN.

MENOMINEE, MICH., *March 15, 1906.*

Mr. G. W. McMULLEN, *Chicago, Ill.*

DEAR SIR: I am in receipt of your letter of the 13th instant relative to your process of drying sugar beets and the results of our experiments carried on in connection with this work. In reply to your first question I would say that I visited your drying plant at Simmons, Mich., in company with Mr. C. I. Cook, and witnessed the drying of some fresh sugar-beet cossettes, the beets having been sliced in the regular way and carefully tested by our chemist for sugar contents and purity before being dried. In observing your method of drying I was impressed with the fact that you had discovered a very simple and natural law in connection with removing moisture from materials, and was surprised at the simplicity of your device; and so far as sugar beets are concerned, would state that from tests made by our chemist of the dried cossettes we were unable to find that there was any disturbance of the chemical relations of the properties of the beets, and I think this is largely accounted for by the fact that the evaporation, or drying, takes place at a low temperature.

In answer to your second question would state that from the analysis made in our laboratory of the dried cossettes, as compared with the analysis of a sample of these same fresh beets before drying, we found that the full sugar contents had been preserved and the purity remained the same, and, so far as we could ascertain, no deterioration had taken place at that time; and, from a series of experiments made at intervals for a few months following the drying of the beets, we could find no changes in sugar contents or purity in these dried cossettes. We shall continue to have experiments made for a much longer period and ascertain if any changes will take place later on. Should we find that there are no changes, I believe it would be fair to assume that, with a sufficient supply of these dried cossettes, a sugar factory would be enabled to operate practically the year round. One factory would thus be able to do the work that five or six are now doing.

In answer to your third question: It would appear from our experience, and, no doubt, from the experience of every sugar factory, that there is a very considerable loss of sugar each year from deterioration through freezing and thawing of the beets or from other causes between the time the beets are harvested and the time they are actually made into sugar by the factory. This was especially true the past season with all factories in this latitude that had any considerable quantity of beets to work up. Were it possible to dry the beets immediately after harvesting, and thus preserve them perfectly, a very considerable saving in sugar would be effected.

In reply to your fourth question, I would state that we prepared in our laboratory a miniature diffusion battery of 14 cells and proceeded to extract the sugar from the dried cossettes. In conducting this experiment our experts were exceedingly careful in their work, and after a series of experiments we found we could extract the sugar by diffusion from the dried cossettes as readily as we could from the fresh ones, and the experiment showed that we could perform this work with much less water. Of course any sugar manufacturer realizes the economy that would be effected by having less water to

be evaporated from their juices; and, as our superintendent reported, this could be done without affecting the operations adversely at the other stations in the house.

So far as our experiments have gone in this work, I might say that there seemed to be no obstacles to be contended with in the drying of the beets by your process and the manufacture of sugar from such dried beets. What remains to be demonstrated, of course, is of very considerable importance, and that is, Could drying plants be erected at outside points and operated at a cost which would enable the sugar companies to install them and proceed along this line? One thing is evident, and that is that there should be a very considerable saving of freight, as between 70 and 80 per cent of the weight of fresh beets would be removed in the form of water; but as to the cost of this part of the operation I am unable to judge, and believe that the only way to demonstrate this in a practical manner would be to erect a slicing and drying station at some point and make an actual test; and, if it is then found that this work can be economically performed, it would seem that a problem had been solved which would, to a very great extent, revolutionize beet-sugar manufacturing.

Yours, respectfully,

G. W. McCormick.

Mr. F. Treskow, general superintendent of the Menominee River Sugar Company, writes as follows:

I am pleased to inform you of the very satisfactory results we had by experimenting with cossettes dried by your drying process. I am certain that cossettes previously dried by your process at a temperature not higher than 155° F. and stored until such time as they would be needed for manufacture will not deteriorate to any appreciable extent. These cossettes will give no difficulty in the diffusion battery or at the following juice stations of the house, and I believe that the extraction in the diffusion battery can be carried on with less water—at least 20 per cent less—which means a great saving in evaporating, and also an increase of capacity of all stations of the beet end.

It can not be said that the process of drying beets, or even the cossettes, prior to extracting their juices by diffusion, has as yet been practically established. Enough of importance has been ascertained by experimentation to make it worthy of more careful and comprehensive tests in the future. Granting that this process will eventually prove practical, it promises a reduction in the cost of sugar produced from beets.

DENATURED ALCOHOL IN RELATION TO THE SUGAR INDUSTRY.

At the present time, on account of the recent law passed by Congress regarding denatured alcohol for use in the arts and sciences, much interest has been aroused in the minds of farmers. The Department of Agriculture has recently published three Farmers' Bulletins relating to this subject, No. 268, devoted to "Sources and manufacture," No. 269, to "Uses and statistics," and No. 277, treating of "Alcohol and gasoline for use in farm engines." These bulle-

tins are for free distribution by the United States Department of Agriculture.

This subject is receiving careful attention from those interested in sugar production, both from cane and beets. Great benefits are anticipated, both directly and indirectly. The manufacture of certain alcoholic spirits has for some time been closely allied to the sugar industry. In the Tropics rum is one of the special by-products of sugar making. The low-grade molasses and juices are used for this purpose. In the beet-sugar countries of Europe an extensive alcohol production has developed in connection with the manufacture of sugar from beets. For this purpose is used the low-grade molasses of the sugar factories. In both Germany and France alcohol is made to a considerable extent directly from beets. More attention is given to this in France. In the United States we have one plant making high-grade alcohol from the waste molasses of the sugar factories, and another for this purpose is being planned.

England has recently enacted laws permitting the use of denatured nontaxed alcohol in the arts and sciences. By legislation Germany and France have encouraged its manufacture for a considerable time. The law of the United States enacted for this purpose went into effect January 1, 1907. In all the countries named legislation encouraging this industry is considerably more liberal for the purpose than our own. People of the United States probably anticipate greater benefits than will accrue or the facts will warrant. No doubt this law lays the foundation for the production of a new and cheap product, greatly benefiting many industries. The bulk of it will continue to be manufactured, as now, by the plants already equipped for producing the alcohol product on a large scale or by other plants requiring large investments. There appears to be a popular impression that every farmer can be a producer of alcohol from his farm products, no matter how small the output. As a matter of fact, any individual can now, as heretofore, engage in alcohol production who will comply with the law; but the actual situation is that only those prepared to go into it on an extensive scale can compete. No new discoveries have been made augmenting the uses of alcohol. Most of its present uses have been appreciated for some time. The only thing barring it from practical application to these uses has been our internal-revenue tax of $1.10 per gallon. National legislation simply relieves the maker of alcohol from paying this revenue, conditioned on his changing its nature so as to prevent its use as a beverage. This legislation specifies certain ingredients in specific proportions which must be added to what is known as ethyl alcohol, rendering it unfit for beverages, medicines, etc. The manufacturer of alcohol must conform to the same rules and regulations

that were previously in force. He pays the same revenue. However, upon notice to the Government that he wishes to denature certain quantities, it will permit him, under its supervision, to add the ingredients it specifies for this purpose. This alcohol is then considered denatured, becomes tax free, and may be removed from bond and sold to the general public for use in the arts and sciences.

The main benefits that will accrue to the farmer will be the stimulus to crop production of those things from which alcohol is made. There is quite a number, such as corn, barley, potatoes, sugar beets, and a number of other plants and roots carrying a large percentage of starch or sugar, or both. It is claimed by those best advised on this subject that alcohol free from revenue tax can be produced to retail for 30 to 35 cents per gallon. This will very much stimulate its use for the various purposes to which it is applicable, and to that extent stimulate the increased production of the different manutures requiring it as a raw material.

It will undoubtedly benefit the rural classes in another way. There has been a great development in recent years in the application of cheap fuel to the production of light, heat, and power. Light engines doing all kinds of work are found practicable on the farm. They are used for grinding feed, shelling corn, cleaning wheat, sawing wood, thrashing, pumping water, and many other things requiring power in the daily routine of farm work. Those inclined to look into the future anticipate that such power will eventually be used generally in propelling stirring plows, cultivators, thrashing, reaping, and mowing machines, and in doing much other work now generally performed by horses. As a rule the gasoline engine has ordinarily been used for such purposes. A thorough study of the situation shows that denatured alcohol may take the place of gasoline to some extent. It is claimed that certain qualities of alcohol make it very much preferable to gasoline. In burning it is less odorous, does not smoke, nor leave a dirt refuse. While the flame is light blue, the heat is intense. Directly it would not serve the purpose of illumination. This can only be accomplished by converting it into an incandescent light by means of a mantle over the flame. This has the property of absorbing the heat rays, becoming incandescent, and reflecting white illuminating rays. For heating purposes this product may be found quite useful in places remote from sources of cheap fuel, such as coal, petroleum, wood, and gas.

Alcohol is used extensively in the production of smokeless powder, varnishes, hats, imitation silk, and, to greater or less extent, in the production of a number of things for which the denatured article can be used. No doubt the lessening of its cost on account of this new law will very much stimulate and assist many industries, and for this

reason its effect will be far-reaching. Time and experience only can demonstrate the most practical sources of its manufacture. Possibly in the end the principal raw materials used in its production may be the by-products from the manufacture of something else.

Dr. H. W. Wiley, Chief of the Bureau of Chemistry, Department of Agriculture, in Farmers' Bulletin No. 268, gives the following table, showing the yield from 100 grams of sugar of the following quantities of the products of fermentation:

	Grams.[a]
Alcohol	51.10
Carbonic acid	49.20
Glycerin	3.40
Organic acids, chiefly succinic	.65
Ethers, aldehydes, furfurol, fat, etc	1.30
Total weight of fermentation products produced	105.65

In the same bulletin he refers to sugar beets and the production of alcohol from them as follows:

The sugar beet is often used directly as a source of alcohol. Working on a practical scale in France, it has been found that from 10,430 tons of beets there were produced 183,624 gallons of crude alcohol of 100° strength. The beets contained 11.33 per cent of sugar. From 220 pounds of sugar 15.64 gallons of alcohol were produced. The weight of pure alcohol obtained is a little less than one-half the weight of the dry fermentable matter calculated as sugar subjected to fermentation. About 18 gallons of alcohol are produced for each ton of sugar beets employed.

In the same bulletin Doctor Wiley speaks of the manufacture of alcohol from molasses, a by-product of the sugar factory, as follows:

The utilization of the waste materials from the sugar factories and sugar refineries for the purpose of making alcohol is a well-established industry. The use of these sources of supply depends, of course, upon the cost of the molasses. When the sugar has been exhausted as fully as possible from the molasses, the latter consists of a saccharine product containing considerable quantities of unfermentable carbohydrate matter, large quantities of mineral salts, and water. In molasses of this kind there is probably not more than 50 pounds of fermentable matter to 100 pounds of the product. Assuming that a gallon of such molasses weighs 11 pounds, it is seen that it contains 5½ pounds of fermentable matter, yielding 2¼ pounds of industrial alcohol of 95 per cent strength. It requires about 3 gallons of such molasses to make 1 gallon of industrial alcohol. The quantity of molasses made in the United States as a residual product from the sugar manufacture is difficult to determine. For each ton (2,240 pounds) of sugar produced we may assume that there are 62½ gallons of molasses. Placing the total output of sugar in the United States at 400,000 tons, beet and cane combined, would give a yield of molasses of 25,000,000 gallons.

The quantity of molasses produced in Cuba is three or four times as great as that produced in the United States, thus affording a very extensive source of production of industrial alcohol should it prove profitable to make it from this

[a] One gram equals 0.03527 ounce.

material. The above data show that when the price of molasses delivered to the refineries falls as low as 5 or 6 cents a gallon it may be considered a profitable source of alcohol.

In 1905 13,500,000 gallons of alcohol were produced in France from beet-root molasses. The production from this source is decreasing—in 1901 almost double the above amount was made.

Representative E. J. Hill, of Connecticut, who assisted Commissioner Yerkes, of the Internal Revenue Bureau, to formulate the rules under which free alcohol went into effect, spent considerable time in Europe investigating the subject. He has outlined the conditions in Germany under which the farmer can practically and profitably manufacture alcohol. He states that Germany is the country in which the greatest progress was found to have been made in the direction of applying denatured alcohol for the development of industrial purposes. There are 70,000 farm distilleries in Germany, many of them being very small. Mr. Hill was asked how the German Government could afford to furnish an inspector to each one of these distilleries. In view of the fact that it has always contended that distilling from residues from beet-sugar manufacture could be carried on only on a large scale, Mr. Hill's information is particularly interesting to the American beet raiser. He says:

There is no difficulty in that respect. The stills have to be made in a certain way, which includes a tank which can be locked with a Government lock and sealed with a Government seal. The small farm distilleries do not operate all the year round. They operate in the winter, when the farmer has leisure to do something other than straight farm work. The farmer has to give the Government thirty days' notice as to the time he wants to begin to operate his still. Some time during the thirty days an inspector comes along and looks the still over to see that it is clean, etc., and then he locks and seals the tank, after which the still is ready for the farmer.

He may go ahead and distill until the tank is full. Then he informs the person who is to buy the alcohol from him, after which he notifies the Government and an inspector comes and removes the seal, measures the contents of the tank, and collects the revenue. If the farmer wants to denature the alcohol on the spot he can do so in the presence of an inspector, when the amount of the tax will be returned to him. But generally the farmers sell through the great central selling agencies, which denature at a central point and in large quantities and collect the rebate from the Government in considerable sums. Thus the Government agents are not required to spend any appreciable time at any one farm and one inspector can cover a large territory. Meanwhile the central selling agency pays the farmer on the basis of beverage alcohol and rebates for all that is denatured. It is a good system and is not very expensive to the Government.

From Farmers' Bulletin No. 269 I clip a table showing the consumption, and for what purpose, of denatured alcohol in France, 1903 to 1905, inclusive:

Consumption and uses of denatured alcohol in France, 1903–1905.

Purpose for which used.	1905.	1904.	1903.
	Gallons.	*Gallons.*	*Gallons.*
Heating and lighting	8,326,084	7,654,287	6,922,218
Varnishes	305,222	328,443	305,909
Polishes, etc.	46,415	47,552	66,095
Plastic materials	562,497	495,874	530,851
Manufacture of hats	6,023	6,287	9,642
Dyeing and colors	14,635	10,329	14,054
Rennet	3,910	2,932	3,751
Collodion	11,016	7,185	3,857
Chloroform	4,914	4,596	9,959
Chloral	10,091	7,978	6,499
Tanning materials	14,978	40,920	21,081
Chemical and pharmaceutical products	178,843	182,410	300,652
Scientific uses	31,515	22,824	13,710
Ethers, fulminates, explosives	2,961,900	2,375,342	1,687,495
Total	12,478,043	11,186,959	9,895,773

IMPROVED IMPLEMENTS AND DEVICES FOR THE BENEFIT OF BEET GROWERS.

During the past ten years many changes and improvements have been made in the implements used in the cultivation, harvesting, and delivery of beets. The farm wage scale of this country is considerably higher than in any other. Wages have advanced considerably during this period. Anything that tends toward the saving of labor affects to that extent the cost of production. To balance the gradual increase of farm wages, we must introduce new labor-saving implements. I note a general improvement of all implements used, and special endeavors on specific ones, which, when perfected, will be far-reaching in their results.

BEET HARVESTERS.

To harvest beets costs from $5 to $10 an acre, depending upon the condition of the soil. Most of this work is now accomplished by a system borrrowed from Europe. This consists in extracting the beets from the soil with an implement drawn by two to four horses. It is in the nature of a plow. There are several forms, one of which is called a "puller." This has two finger-like tapering prongs which run through the ground parallel with the surface, but about 10 inches below. The space between these prongs is wider at the points, gradually lessening to their back ends. These prongs are supported by two upright pieces attached to the beam. When pulled through the soil the points are carried on either side of the beet, compelling it to pass through this diminishing space. Directly the prongs tighten against the beet as it is being forced through the space, breaking off the top root and forcing it up. The beet is elevated 2 or 3 inches and left in the loose dirt.

Another form of the implement consists of a plow with a narrow moldboard and a long sharp knife-like share, the edge of which penetrates the soil at about the depth of 10 inches, cutting off the beets, lifting them several inches, and throwing them on the side over against the loose dirt. A workman comes along the row, takes hold of the top, lifts the beet from the loose soil, and with a sharp knife cleaves off the crown from which the leaves have grown. The beets are then bumped together to remove the adhering dirt and thrown in piles, and the tops in others. From these piles the beets are loaded into wagons and delivered to the factory.

Harvesting involves considerable hand labor. A man and team can only plow out one row at a time. Inventive ingenuity in Europe, and especially in America, has been directed to planning a harvester which will do away, as far as possible, with this expensive hand work. Quite a number of harvesters for this purpose have been devised. Some of them are intended to do only a part of the work described; others are more complex, and are planned to accomplish all of it. For instance, one machine is designed simply to pass over the row and cleave off and pile the tops. Several others not only remove the tops, but extract the beets and place them in piles. Some implements have been constructed which top the beets, have an arrangement for jarring off the adhering dirt and forcing their surface against a system of brushes, thus cleaning them as fully as possible. Some have an elevator to carry the beets into a wagon drawn along the side of the harvester.

It can not be said that any of these newly devised implements works successfully in all soils. No doubt great improvement is made from year to year. The present drawback to an absolutely universally competent machine is the variable nature of soils. Some soils are mellow sandy loam, from which the beets are easily extracted; others are compact and hard, requiring considerable power. The amount of moisture at harvest plays an important part. The more complex the machine, as a rule, the more power required, and the heavier the implement. There is no doubt that most of these machines do acceptable work under the conditions of soil for which they were more particularly designed. The obstacles have been largely overcome in particular cases, because the problems have been studied and the difficulties met. It is the universal harvester we are now seeking. It is the general belief of those most interested in the beet-sugar industry that it will be perfected eventually. When it is, it will solve one of the main objections offered by farmers to beet growing. It will materially reduce the expense of their production.

As an evidence of the importance of such an implement, I clip from The American Sugar Industry and Beet Sugar Gazette of May 5, 1906, the following:

Consul Hannah, writing from Magdeburg, says that the Verein der Deutschen Zuckerindustrie has offered a prize of $2,380 for a machine that will solve the problem of satisfactorily digging beets and heading them at the same time. The papers of the contestants are to be sent so as to reach the main office of the association up to July 15, 1906. The decision as to the granting of the prize will be given by a board of judges selected by the director of this association and will be published. The prize will be awarded as soon as a beet digger and header has been shown which satisfies all requirements.

METHODS AND DEVICES FOR UNLOADING BEETS.

I note a very remarkable change throughout the country in the means and methods of delivering beets to the factory. Like harvesting, this is a rather expensive feature. Not only have better devices for this purpose been arranged for the use of the farmer, but better systems have been inaugurated for the saving of his time. A few years ago it was quite common to see farmers waiting their "turn" in a long line at the factory. The beets were thrown into the bins by hand with shovels or beet forks. By very much increasing the capacity of the beet sheds this congestion has been considerably eliminated. It is also becoming quite the custom after the sheds are filled to pile the beets on the ground by the railroad tracks, etc., in the vicinity of the sheds, permitting them to lie there until worked. Many factories have added dumping facilities for depositing a carload of beets in the bins at once. Some factories use a system of nets. Two or three of these are placed in a wagon box before the beets are loaded. The bins are equipped with hoisting cranes which take hold of these nets, lift them, and thus drop the beets into the bins.

Probably the best wagon-dumping device of a sugar factory is that at Fremont, Ohio. The bins are so arranged that the wagon-load of beets is driven over them onto an automatic dump. The team is then unhitched from the wagon and the whole load of beets is precipitated into the bins below. This performance requires only three to five minutes. These long beet bins are arranged side by side. It is necessary only to have one set of automatic dumps. They are on tracks running at right angles with the bins and can be made to travel from one bin to another.

Aside from the general improvement in dumping facilities at sugar factories, there is to be noted a tendency quite prevalent throughout the beet-growing area to build "country dumps." These are located outside of the 6-mile or wagon limit. At some feasible

point the railroad puts in a side track and switch. Along this is erected an automatic beet dump, with long approaches at either end. This country dump is usually equipped with a weighing and sampling station. The farmer drives up the incline with his load of beets after weighing and sampling by the agent. The wagon is then hauled upon the dump and fastened securely to it after removing the team. By automatic action the beets are thrown down over an apron into the cars below. This greatly increases the area growing sugar beets. In my reports I have noted the introduction of these country dumps from time to time. They are coming generally into use. There are of course some objections to automatic dumping. It has a tendency to increase the tare of the beets and to deposit a large quantity of dirt and refuse in the bins. This dirt tends to choke up the sluicing ditches which convey the beets to the factory and requires considerable expense in removing it.

Automatic dumping of sugar beets, either at the factory or in the country, is receiving careful study from factory managements and designers. The three points of improvement aimed at are to increase the efficiency, decrease the cost, and eliminate the objectionable features.

I have devoted considerable investigation to dumping. Sometimes it is possible to adopt a device already worked out for accomplishing a certain work and made to do service somewhat similar in kind yet different in purpose. A short while ago while in a heavy corn district in the State of Illinois I observed in operation a combined corn dump, elevator, sheller, grinder, and conveyor of the ground corn to the feed lots or barn. The process was very simple. A wagonload of corn was driven along a large granary, the front wheels were allowed to drop into certain elongated cups about 8 inches deep, conforming to the shape of the wheel. The team was detached from the wagon and hitched to an ordinary horsepower used in operating the dump. The back end gate of the wagon box was removed; the power was started in motion. The cups were elevated, carrying with them the front end of the wagon until it reached the inclination necessary for precipitating the corn into a box below. Through the bottom of this box, attached to a belt, were cups or conveyors for carrying the ears of corn up an elongated box receptacle and dropping them into the granary, or sometimes it carries them to the sheller. After shelling another conveyor takes the grain to the grinder and another to its final destination, possibly feed boxes in the yards. All this was accomplished by the horsepower outside. The features capable of adaptation to the beet industry are the outside apparatus, consisting of the horsepower, elevator of the wagon front, the box receiving the load, and the conveyor to the top of the granary. In the case of beets this would be the bins. With modifica-

tions for use in beet delivery all of this might be made very useful. For this purpose I would add one or two things to complete its usefulness. The bottom of the outside elevator carrying the beets to the top of the bins should be openwork, made of round steel bars, through which the loose dirt could fall. For catching this loose dirt under this elevator conveyor I would have another receptacle attached to a crane and automatic weigher. This method would separate the loose dirt and débris from the beets, weigh it, and dump it back into the wagon. With very little trouble the farmer could haul it to some common dumping ground. A device of this kind would be advantageous in two or three respects. It would keep out of the bins the loose dirt which causes objection to automatic dumps. It would weigh this dirt in the presence of the farmer and do away with a great deal of the contention occasioned by the present system. Now the farmer must rely solely on the fairness of the factory agents in estimating his tare from the samples of beets taken.

BEET WAGONS.

I notice considerable transformation of the vehicle used in conveying the beets to market. Formerly as a rule beets were hauled in ordinary farm wagons, with the usual boxes. We see now for this purpose many specialized forms of boxes. These are devised to haul as large a load as is practicable and to unload as easily as possible. In many of these are introduced certain features of automatic dumping. Forms of these boxes are various, all tending to accomplish the most in the easiest manner, at the least expense. In the most favored beet-growing districts one or more devices are adopted with these ends in view. I clip from the Hutchinson (Kans.) News of Thursday, August 2, 1906, an article on one of the newest devices arranged for this purpose:

To facilitate culture and enable them to produce and deliver their crop with the greatest ease possible seems to be one of the chief endeavors of the United States Sugar Company in behalf of the farmers who are to supply the factory with beets for the campaign. To this end still another departure is being made in the line of implement equipment.

Two hundred beet wagons or dumps are now being manufactured here in Garden City and will be sold to the beet-raising farmers at cost, which will probably exceed but slightly $55. The one object of this is to render beet delivery easy and prompt.

The new dump will consist simply of a body with drop sides, bottom and sides giving away simultaneously from the center at a touch upon a lever by the driver, who does not leave his seat. The beets fall into the bins in the shed below and on either side. The sides are automatically replaced and the outfit is then driven on.

There are to be two sizes made, the 3-ton and 4-ton. The contrivance can be used on a standard running gear—that is, a 38-inch bolster.

USE OF GANG PLOWS AND STEAM ENGINES IN STIRRING THE GROUND.

Stirring of the ground is one of the particular features in preparing the seed bed. This should be thorough and, as a rule, at greater depth than is usual for other field crops. Owing to exigencies of the season it is desirable to cover considerable in a short time. The sooner the plowing of land is accomplished the better. Prevalent weather conditions may retard the plowing and planting. The pressing requirements of other crops may limit the farmer's time. It is desirable to have the land ready to plant at the most favorable moment. Weeds germinate and get an early start. We can cultivate and harrow the lands and get much of the weeds and grass killed before planting begins. If this plowing is done early, it gives the farmer much more opportunity for doing the preliminary work of preparing the seed bed. The necessities of the case have been so thoroughly demonstrated to the farmers in the beet districts that they are alert to learn and adopt all the best methods for accomplishing this work.

The lay of the land in many of our beet districts is well adapted to the traction plow propelled by steam or other power. During the past season progress was made in the introduction of these plows, and from local reports it would appear that their adaptability to the purpose proved highly satisfactory. It is evident they will be used much more in the future. I observed that this system of plowing lands was quite generally in use in the Hawaiian Islands. In those islands plantations are large, even-surfaced tracts, mostly belonging to or leased to the sugar companies. Planters there exercise all of their ingenuity and skill and utilize all their advantages. Since beet growing succeeds best where there is full utilization of the highest advantages, I predicted several years ago that some of the advanced methods in the Hawaiian Islands would eventually be employed in the beet-sugar industry in this country. In the introduction of the steam gang plow we see a fulfillment of this. While the gang plow has come into use in several sections of the country, its use is not general. I reproduce here an article taken from the Tulare (Cal.) Weekly Register of March 23, 1906. This gives a specific account of the operation of one of them:

A representative of the Register this forenoon visited the scene of operations on what is known as the "Goldman colony tract," near Tagus, where Mr. J. S. Montgomery is superintending the planting of a large acreage to sugar beets for the Tagus Sugar Beet Company, of which he is a member. A big traction engine is the principal factor in the work, and it is moving over the land with three six-disk plows and a Randall plow in its trail, cutting up 30 acres a day. The ground is being plowed to a depth of 12 to 14 inches, and as I rode around on the back of one of the plows and watched the sod curling over from the 18 disks I mentally contrasted present methods with those of my childhood, when I sat on the fence and watched my father, with the lines

noosed over his neck, steering a single plow behind a span of horses. This traction engine is built for three more similar plows, giving a capacity of 60 acres a day.

In another part of the immense field a seeder was at work, and to-morrow two more will be put on, as the cessation of the rains has given the plows and harrows a chance to get ahead again. On that part of the tract where the seed was planted before the rain stopped operations, the beets are showing themselves conspicuously in rows farther than the eye can reach.

That there will be a fine crop of beets on that land there is no room for doubt, as the company has one of the best pumping plants in the country and the soil can not be surpassed anywhere.

FLUMING BEETS.

During the past year I noticed the introduction experimentally of fluming beets to the factory. This practice is quite general in cane production in the Hawaiian Islands. It has been used in this country to a considerable extent in other lines of industry. In Hawaii much of the cane is brought in by fluming from the fields to the factory or to some point on the road accessible to it. As a rule the ground is gently sloping from the cane field to the factory. Flumes are made of wood and galvanized iron or other material similar to these. In form they are triangular, with cross section like the letter V. In our lumber districts much of the lumber, wood, posts, and billets is brought from the sawmills in the mountains to the highways and railroads by floating through a flume. There are many places where fluming would be a practical method for conveying sugar beets to the factory. In Hawaii considerable of the fluming apparatus is portable. The main flume may be stationary and permanent. Side flumes for conveying the cane to the main channel are movable from field to field. This system would not only convey the beets to the factory, but thoroughly cleanse them. Tarring would be reduced to the minimum, and a part of the work of the factory would be accomplished.

An experiment in fluming beets was made at Bozeman, Mont., last year. The people in this vicinity are very anxious to secure a beet-sugar factory. They have carried on experimentation in growing the beets to a considerable extent. I reproduce here an article written by A. Buchanan, of Bozeman, to the American Sugar Industry and Beet Sugar Gazette of June 5, 1906. He had charge of this experiment and gives the results as follows:

An experiment in transportation that may be of interest to manufacturers and growers throughout the country has just been successfully concluded here, and, it is believed, has solved the problem of handling beets in a section where other means of transportation are limited, but where there is an abundance of water. The gentlemen who are promoting the sugar industry in Bozeman have been confronted by a difficult problem. A large part of the choicest acreage in the Gallatin Valley is outside of the 5-mile limit, and in one part of this

district considerable acreage has been signed up, subject to the erection of a slicing station. The amount of acreage, however, has hardly been sufficient to justify the building of an extensive slicing plant, so the promoters have cast about for other means of getting the beets to the factory at a small cost. A suggestion by one of the sugar-beet committee that the beets be flumed to the factory was taken as a practical one, and the experiment was concluded recently.

The trial was made with a flume that runs from the Gallatin Mountains to Bozeman and is used for carrying railroad ties from the forests that cover the mountain sides to the railway at Bozeman. The flume is a V-shaped wooden box with sides 24 inches, set together at right angles. This left the open top about 34 inches across. For this experiment a volume of water that filled the box about halfway to the top was used. The flume has an incline of 1 inch to the rod, or a little over 26 feet to the mile. The distance covered by the experiment was a mile and a quarter. About half a ton of beets were used in the trial, and these were dumped into the flume as rapidly as possible, in order to "bunch" them. The beets arrived at their destination without mishap, the last of them getting there within eight minutes after they were put into the flume. When they were taken out of the water, they were as clean as if they had gone through a washer.

While it may appear that too heavy a drop was utilized, that will have no bearing on the practical nature of the experiment in this valley, as the land here lies at about the same angle, and in many places the slope of the valley is even greater. There is plenty of water that can be utilized here for fluming, and all of the prospective acreage is considerably higher in elevation than the proposed factory site. By building a main flume up the valley and having feeders at convenient intervals, it is believed that beets can be delivered at the factory in clean condition for far less money than even a slicing station can handle them.

Further experiments, in which a flume with less drop to the mile will be used, will be made as soon as the special flume can be constructed, but those who witnessed the experiment are fully satisfied that beets can be floated down to the factory without difficulty even with one-third of the drop above mentioned.

While the experimenters are thoroughly satisfied with the result of the trial, they realize that there may be some unforeseen objections that a factory expert might point out, and I therefore submit this brief account of the experiment in order that those more familiar with the business may pass upon it.

The farmers in the Gallatin Valley are planting about 200 acres of beets this year as an experiment, under the direction of a factory expert from Ogden. These will be shipped to the Billings factory.

CLIMATIC CONDITIONS AND FARM AND FACTORY RESULTS FOR 1906.

The progress of the beet-sugar industry can be determined best from actual results. Under this heading I give a résumé of conditions obtaining in the various parts of the United States, outlining to some extent the general character of the season during 1906.

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FACTORIES IN OPERATION.

Taking the country as a whole, no other year has presented results so generally satisfactory. All things considered, the factories of the United States are approaching the season of 1907 under most favorable auspices. As a rule farmers are contracting for acreage readily and seem well satisfied. There are now sixteen States in which beet-sugar production is going on. In the table below will be found the number of factories in each, with the capacity of each, and the total capacity for working beets per diem represented by the factories in each State:

Beet-sugar factories in the United States in 1906, with localities and capacities.

Location.	Capacity.	Location.	Capacity.
Arizona:	*Tons.*	Michigan—Continued.	*Tons*
Glendale	800	Holland	350
		Lansing	600
California:		Marine City[a]	350
Alvarado	700	Menominee	1,000
Betteravia	500	Mount Clemens	600
Chino	900	Owosso	1,000
Hamilton	1,000	St. Louis	600
Los Alamitos	700	Salzburg	400
Oxnard	2,000	Sebewaing	600
Spreckels	3,000	West Bay City	600
Visalia	350		
	9,150		11,250
Colorado:		Minnesota:	
Brush	750	Chaska	600
Eaton	600		
Fort Collins	1,200	Montana:	
Fort Morgan	600	Billings	1,200
Grand Junction	500		
Greeley	800	Nebraska:	
Holly	600	Grand Island	350
Lamar	400	Leavitt	1,100
Longmont	1,200		1,450
Loveland	1,200		
New Windsor	600	New York:	
Rocky Ford	1,000	Lyons	600
Sterling	600		
Sugar City	500	Ohio:	
Swink	1,200	Fremont	400
	11,750	Oregon:	
		La Grande	400
Idaho:			
Blackfoot	600	Utah:	
Idaho Falls	1,200	Garland	1,200
Nampa	750	Lehi	1,200
Sugar	1,200	Lewiston	600
	3,750	Logan	600
		Ogden	400
Illinois:			4,000
Riverdale	350		
		Washington:	
Kansas:		Waverly	500
Garden City	1,000		
		Wisconsin:	
Michigan:		Chippewa Falls	600
Alma	750	Janesville	600
Bay City	600	Madison	600
Blissfield	600	Menomonee Falls	500
Caro	1,200		
Carrollton	800		2,300
Charlevoix	600		
Croswell	600	Total capacity	49,500

[a] This factory was not in operation in 1906.

ARIZONA.

Agricultural conditions favorable to beet culture have been quite thoroughly tested in Arizona. For several years capitalists, promoters, business men, and farmers have conducted experiments in many of its valleys. Where favorable, conditions are quite similar to those in the valleys of California.

At a small place called Glendale, about 8 miles from Phoenix, Ariz., a factory has been located. Crop production here of all kinds is promoted largely through irrigation by means of ditches connecting with Salt River. Beets are usually of high quality, and the yield is good. This factory at Glendale has been constructed under a chain of very unfortunate circumstances, largely due to misconnections of plans of those building it. Its inception dates back nearly three years, and it has been building for over two years. Its construction was impeded by litigation. Before the building was completed or all of the machinery installed it got into the hands of a receiver. During the early spring of 1906 these matters were adjusted, a small acreage was secured under contract with the farmers, the building was completed, and its machinery and equipment installed. It ran a short, unsatisfactory campaign and got into further legal difficulties.

In this district beets should be planted early. It is the opinion of those best advised as to the conditions that planting should be done from the middle of December to the middle of February. This will permit the opening of the factory campaign from the middle of April to the 1st of May. Beet plantings for this factory in Arizona will occur earlier than at any other place in the United States. The beets will receive the rainfall of winter; at this place this is the most favorable growing season for crops of this nature. During the summer the weather becomes very warm and dry, and is not so favorable to sugar manufacturing as in the spring. Beets rapidly deteriorate when they are taken from the ground under such conditions—one of the things especially demonstrated during the past year. The campaign opened on August 11—very late—on account of tardiness in completing the plant. The management had contracted for about 3,000 acres. On account of the planters becoming discouraged from constant delays and unsettled prospects of the factory, considerable reduction of this acreage was made. Notwithstanding the lateness of the crop, the season was quite favorable and demonstrated much to the credit of the district in growing beets.

One thing especially is worthy of mention: The conditions are such that beets can be left in the soil for a considerable length of time after they are ready for harvest without deterioration.

It may be said that through the results of the past year's work the feasibility and practicability of growing sugar beets in the valley were thoroughly demonstrated. Under the reclamation act the Government is constructing near Phoenix one of the largest impounding reservoirs and irrigating ditches in the country. This ditch and its laterals are assured a permanent and sufficient supply of water for developing a large area.

While the demonstration of favorable agricultural conditions has been sufficient, on the other hand the operation of the factory itself was somewhat discouraging. Irrigation water for the lands is supplied from the Arizona Canal. At the same time the plant, for operating purposes, received most of its water from the same source. Shortly after beginning, the canal was subject to unusual and numerous floods and breaks, resulting very unfavorably to the factory's operation. The water became unfit for its use. For a sugar factory water should be pure and clear. The water coming to it through the ditch was dirty and charged with débris, necessitating special filters and other devices for clearing it. Even then a sufficient quality and quantity of water could not be secured to operate the factory. At the factory were two deep wells, upon which it drew for a partial supply. This soon became exhausted, making it necessary for the factory either to shut down or to fall back on its expensive system of clarification. An extensive break in the canal occurred, owing to one of these floods, which necessitated closing for a considerable time. Many of the beets had been harvested and lay in piles in the fields or in the bins of the factory. Owing to the prevalent hot weather which occurs in that climate at this period of the year, these beets rapidly deteriorated, occasioning considerable loss to the farmers and to the factory. Beets in the ground, not harvested, remained in very fair condition.

In addition to obstacles encountered by the factory through its inadequate water system were certain labor troubles. All these things tended to delay its completion and seriously affected its operation. Several of the experts brought to this point to engage in its operation became tired of waiting and returned home. It became necessary to use a number of unskilled persons in the factory's force. Phoenix is out in a rather inaccessible district. Labor is not easily secured, especially those skilled in the work of the sugar factory.

Through all these difficulties the factory managed to make raw sugar only. Sufficient white granulated sugar was produced to prove the factory's ability to turn out a first-class article. Under the conditions this was at prohibitive cost. The factory ran about twenty-five days and closed down. It was operating at too much expense. Farmers were notified to deliver no more beets; to weigh

them and make an account of them, as they would eventually be paid for, but they would have to be used for feeding and other purposes. These experiences were all very unfortunate. However, through it all the fact that sugar production has a place at Glendale was well demonstrated. The sugar industry's future in Arizona is somewhat in doubt. The affairs of the factory should be adjusted, permitting its practical operation. An ample supply of pure water for its use at all times must be guaranteed by the completion of the Government irrigating system and the sinking of more deep wells at the factory. Plans are being matured for bringing about these conditions, and it is fair to state that the factory will start out under more favorable auspices in its next campaign.

CALIFORNIA.

The first successful plant operated in the United States was at Alvarado, in Alameda County, near San Francisco. It has now been enlarged and improved to such an extent that there is very little of the old factory now in existence. It has, however, through its long successful career, established a permanent condition of beet production such as we may well look for eventually in connection with more of our factories. It has gone through all the phases of discouragement due to drought, disease, pests, and other things affecting the production of beets. These things are found to affect the beet crop through a long series of years the same as other crops, and not more often or accompanied with more hazard. Seasons have occurred in this district when there was failure to produce sufficient beets to run the factory except short campaigns. In a new district such an occurrence would be most discouraging. Its effect would be felt for several years to come. This demonstrates that confidence in this new industry can only be assured after several years' experience.

I have called attention in previous reports to the fact that some years ago California built factories beyond its assured production of beets. Several factories were built in a short period. Soon after droughts occurred and diseases attacked the fields, giving California factories short runs for several years. Each of these districts has been gradually increasing its beet-producing capacity and working up confidence similar to that at Alvarado. While several of the plants were enlarged during the past few years, no factories have been installed until the past season, when two additional new ones were built. This is one of the best assurances that the old ones have sufficiently developed the productive resources of their districts to assure ample supplies of beets.

Most of the factories in California are large—considerably above the average. It has two of the largest factories in the United States,

and one which is the largest in the world, with one exception. Most of the older factories were built on the coast, or near it. This was largely due to natural conditions favorable to beet production. On the coast side of the mountain ranges in California water seeps or percolates through the substrata of the soil from the mountains to the sea. To plants this affords a system of subirrigation. Until the last few years very few of the beets grown in the State were irrigated. Between the middle of January and the 1st of March, as a rule, the State has considerable rainfall, under normal conditions the precipitation ranging from 10 to 25 inches. During this period, for most of the coast valleys south of San Francisco, the weather is quite favorable to planting and growing crops, particularly the root crops. Especially is this true in the southern part of the State, and to greater or less extent in the districts near San Francisco. This part of the State is better and later supplied with rainfall in the spring. Under these conditions the beets germinate and grow to a considerable size before the cessation of rain. By the time the dry weather comes on the beet roots have gone down to considerable depth, reaching the strata moistened by subirrigation through natural drainage and seepage from the mountains. This carries the beets on to maturity.

While originally beet growing in these coast valleys was dependent exclusively on winter rains, the industry has been augmented in recent years to a considerable extent by irrigation. As a rule such irrigation is depended on to alleviate conditions in case of drought. Subdrainage of water from the mountains, through these valleys to the ocean, affords many opportunities for securing deep artesian wells. Many of these are utilized in irrigating lands.

The two new factories—one at Visalia, the other near Chico—are built in valleys on the east side of the Coast Range, depending generally on irrigation. They have conditions entirely different from those generally obtaining around the older factories. Chico is in the Sacramento River Valley, in Butte County, about 150 miles north of San Francisco. Visalia is about the same distance northwest from Los Angeles, in Tulare County. Both of these are in the inland basin between the Coast Range and the range of mountains east, into which comes the natural drainage from mountains on both sides, affording resources for irrigation. These valleys are very productive, especially the Sacramento Valley, in the northern part of the State, which covers a large area, upon which are grown the cereals, fruit, root, and hay crops. Throughout there are many of these inland districts, well watered and resourceful, capable of engaging in sugar-beet production. No doubt the work of these two factories will demonstrate its feasibility and lead to the construction in

the near future of many new factories in this interior part of the State. It appears probable several will be located in the Sacramento River Valley.

California has an extensive and rapidly growing fruit industry. Its distance from market makes preserving and canning, especially of the perishable varieties of fruit, desirable. In these processes sugar is used to a considerable extent. With the development of these industries the demand for sugar in the State is increasing at a rapid rate.

Sugar beets are known to be one of the best crops for rotation and soil improvement. Many of the valleys are devoted to growing small grain. It is found necessary occasionally to summer fallow the grain lands, cultivating down the weeds, and resting the land. By using sugar beets in rotation the same thing can be better accomplished, and an additional crop secured.

For growing beets conditions were very favorable in the State during the past season. To the beet-sugar industry it was the most profitable year of its history in the State.

Sugar production from beets in California does not represent nearly all of the finished sugar produced in the State. Located in California are two large sugar refineries, one being at San Francisco, under the direction of Mr. Claus Spreckels. For several years this plant has refined nearly the entire output of the raw sugar manufactured in Hawaii. The Hawaiian Islands manufacture at the present time about 450,000 tons of raw sugar, doing no refining. This is an amount in round numbers nearly equal to the entire production of beet sugar in the United States in 1906. Mr. Spreckels and those interested with him are also interested in several of the sugar factories in Hawaii and receive for refining their output of sugar. After being refined some of this sugar goes onto the coast markets in competition with beet sugar manufactured there. The rest of it is shipped east over the transcontinental railroads or by ship around the Horn. This sugar goes into the markets of the Mississippi Valley and farther east. In addition to refining the raw sugar of the factories in Hawaii, in which the Spreckels are interested, the management of the refinery has had an arrangement with the other factories of those islands for refining their output of sugar.

During the past year a large number of the sugar companies of the Hawaiian Islands entered into an arrangement with another sugar refinery and beet-sugar manufacturing company, whose plant is located at Crockett, Cal. It has been converted into a purely refining plant. Most of the sugar now produced in these islands is refined at this plant in competition with the one at San Francisco. This has necessitated importations of raw sugar by the San Francisco refinery from Cuba, Java, and other tropical countries, and has

added considerably to the output of sugar refined on the coast and to the amount of cane sugar entering our western markets in competition with beet sugar. The Crockett refinery is located on the San Francisco Bay, about 30 miles northeast of San Francisco, near Martinez.

BETTERAVIA.—The plant located at this place, of 500 tons capacity, has been operating under the direction of the Union Sugar Company, which also controls the factory at Alvarado. The company had intended to increase the capacity of the plant during the past year by the installation of a new 750-ton diffusion battery. This machinery was at San Francisco at the time of the earthquake and fire and was more or less damaged. On account of delaying the adjustment of insurance the factory was compelled to start with the old battery.

From the beginning this factory has been one of the most successful operated in this State. Beets give good yields of excellent quality. Some of the beets grown for it are planted before the winter months; others are planted in succession during these months. This results in a greatly prolonged harvest or rather a succession of harvests. The management is able, as a rule, to secure all the contracts desired. On account of the large acreage planted and the long season for maturing beets, its campaigns are usually of considerable length.

The agricultural district surrounding the factory has a fine irrigation system, and most of the beets are grown under irrigation. The past season was most favorable. Results of the campaign are regarded as the best in the experience of the factory.

CHINO.—The factory at Chino, operated by the American Beet-Sugar Company, has a capacity of 900 tons per day. It is located about 30 miles east of Los Angeles, in a fertile coast valley. The beets for it are grown both by irrigation and rainfall. It is the second oldest factory in the State. Conditions are well established and understood, and it usually has a sufficient supply of beets. It is gradually increasing the area of cultivated lands under irrigation. The yield and quality of beets are generally good. In the district some beets are planted as early as December, and most of the acreage is planted by the middle of March. In 1906 about 1,000 acres had been bunched and thinned by this date. Its campaigns usually open about the middle of July. The one just closed opened July 27 and proved to be one of the most satisfactory in the factory's history. Prior to its commencement many important improvements were made. Among others a new ice plant was installed, the diffusion battery was enlarged, and a new plant for lighting was installed.

When the factory is working at its full capacity it employs, skilled and unskilled, about 350 men. These are divided into two shifts, and the factory runs day and night seven days in the week.

HAMILTON.—A factory is located at this place of 1,000 tons capacity, operated by the Pacific Sugar Construction Company.

This district is in the northern part of California, on the Sacramento River, about 14 miles from Chico, and on the Southern Pacific Railroad. It was built last year and is the first plant installed in the fertile valleys of the Sacramento. It is anticipated that through the demonstrations of this one several others will follow in the valley.

This plant was built almost entirely with southern California capital. A number of the most influential and successful business men of Los Angeles and other points are interested parties. Ex-Senator Thomas R. Bard is its vice-president. Mr. Hamilton, of New York, who was for a number of years prominent in the operation of the American Sugar Company, was the prime mover in the establishment of a factory at this place. The company bought about 10,000 acres in Glenn and Butte counties. These lands are located along the Sacramento River. A new town was established at this place and is building up very fast. It is the purpose of this company to devote the entire area of its cultivated lands to growing sugar beets and other necessary crops in rotation. The tract is to be divided up into 25-acre lots, upon each of which will be placed a tenant engaged in the production of sugar beets. A number of settlers were brought in for this purpose, mostly of German extraction. Quite a number of Japanese were also brought in, and the lands were leased to them.

This company has installed almost everything in the way of improved modern equipment. It has built a fine irrigation system, put in an electric pumping plant on the banks of the Sacramento, established electric car lines penetrating its beet-growing district and connecting with other towns. It is building extensive cattle yards, in which it proposes to feed the pulp from the factory. It is introducing the most modern agricultural implements, among others the gang plow.

This being the first year of the factory's operation, and pioneer work being necessary to develop conditions for producing the beets, the tonnage was not as large as the factory will regularly require. Indications point to a much larger tonnage next year and a more rapid and higher development of the agricultural conditions.

The tonnage was reduced on account of the San Francisco fire burning the pumps which were intended for use in irrigation. This interfered with irrigation at the proper time and resulted seriously to beet growing. None of the farmers were accustomed to beet culture, and it was difficult to persuade them to give the proper care to the crop. The army worm interfered considerably, stripping the beets of foliage and also affecting the sugar contents and purity. Nevertheless, beets ran as high as 24 per cent of sugar and 89 in

purity. Some land, properly taken care of, produced as high as 28 tons per acre. The company is introducing alfalfa, sowing this year about 600 acres to feed with the pulp.

Under the conditions existing in this district beets can be planted from December 15 to April 15, giving it a long season for planting and producing beets, thus extending the campaign of the sugar factory.

Los Alamitos.—A factory of 700 tons capacity is operated at this place by the Los Alamitos Sugar Company. It is about 20 miles south of Los Angeles, near the ocean. Beets are grown both by irrigation and rainfall. For the first few years upon rainfall depended the entire crop of beets for the factory. More recently artesian wells have been sunk; also there are better assurances of beet production under dry conditions. The winter rains were abundant for planting and growing beets, and much of the area was planted as early as December.

In the Los Alamitos district the winter months were quite damp. In November, 4.48 inches of rain fell. December was comparatively dry, having 0.12 inch of rainfall. This allowed the farmers to get their land in good shape for seed bed. January had a rainfall of 2.57 inches; February, 2.24 inches. Most of the planting was done during this month and the first part of March, which was a wet month, with 5.46 inches of rain; but April had only 0.51 inch. May was fair, with a rainfall of 1.17 inches on the 26th and 27th. This rain injured the crop considerably, as the ground was already wet enough. It caused the beets to keep their roots near the top of the ground, resulting in light tonnage. In June were some very hot days, interspersed with others which were cool and foggy. The damp cool weather produced tops very rank and tender, and about the middle of the month three very hot days "cooked" the foliage to such an extent that the beets did not recover readily. This, with the late rain in May, reduced the crop about 20,000 tons below the yield anticipated from the experience of previous seasons.

The campaign was prolonged about fifteen days on account of lack of cars to supply sufficient limestone for daily requirements. The railroad failed to furnish sufficient cars.

During the early summer, before commencing the campaign, many improvements were made on the factory. Oil is used for fuel. The factory now disposes of its pulp, though at its beginning this was almost an entire loss. Pulp feeding has become quite general among the farmers throughout the district, which is developing considerable feeding and dairying.

The quality of the beets grown in this district, as shown year after year, is better than at any other place in the United States.

Below I clip a statement made by the Anaheim Gazette, a local newspaper, giving the average sugar contents and purity of beets for twelve consecutive days ending August 18:

Sugar contents and purity of beets at Los Alamitos, Cal., August 6–18, 1906.

Date.	Percentage of sugar.	Purity coefficient.	Date.	Percentage of sugar.	Purity coefficient.
August 6	21.68	82.8	August 13	19.95	81.5
August 7	20.79	81.8	August 14	20.27	82.3
August 8	19.62	81.2	August 15	19.46	82.5
August 9	19.45	81.7	August 16	19.15	81.8
August 10	19.62	81.8	August 17	18.55	81.4
August 11	19.52	81.2	August 18	18.89	81.6

We often find individual beets running as high as those shown in the above table; but as these are averages for daily runs of all beets sliced in the factory the showing is simply remarkable, though it accords with usual results of the district.

OXNARD.—A plant of 2,000 tons capacity has been operated at this place by the American Beet Sugar Company for several years. It is a model of sugar production in California. Although of unusual capacity, it generally has long campaigns. Beets in the district run very high in sugar.

The factory is equipped with almost everything modern in the way of appliances and facilities for a sugar factory. It also utilizes to the best advantage all the secondary features incident to the sugar industry. For instance, it has established numerous feeding pens, from which are annually fed large bunches of cattle. For this purpose it consumes pulp extensively. Local farmers and dairymen generally use pulp. The company has considerable land of its own. It carries on extensive experiments for the benefit of general beet production. Its cattle graze in the beet fields, consuming the tops and leaves after beets are harvested. In addition, they are systematically fed on a ration containing pulp.

Twenty years ago there was very little agricultural development in this district. The cultivated arable lands in use were usually planted to small grains, and the yield was small and general results not very satisfactory. The bean crop is extensively produced in the county, and in recent years has yielded increased profits.

Eight years ago this sugar factory was built. The inspiration given to the whole district has been something remarkable. At the time the factory was built its location was simply a small town where hay and beans were delivered, and, to some extent, fruit. To-day it is a well-built town of 3,500 inhabitants, business is prosperous, and in comparison with other towns of the State it ranks very high as a business point. At the time lands were devoted to hay, beans, and

the cereals, they were worth, at the outside, less than $50 an acre. Now lands in that district are worth from $250 to $400 an acre. It is not probable that there would be many acres on the market even at those figures. Farmers growing beets for this factory get, on an average, $40 to $50 net returns per acre. This would give the average acre a net earning power of 10 per cent if valued at $400 to $500.

With the rest of the factories of southern California the district enjoyed a bountiful rainfall during the winter, lasting up through May and into July. The yield of beets was large and the quality excellent.

SPRECKELS.—A beet-sugar factory of 3,000 tons capacity is operated at this place by the Spreckels Sugar Company. The location is a little town known as Spreckels. This is near the town of Salinas, about 118 miles down the coast from San Francisco.

Beets are grown in a large fertile valley. Every year a large tonnage is secured. While the new factories building and those making enlargements in the State were affected by the recent earthquake, which damaged machinery on the road, the factory at Spreckels was itself seriously damaged by this disturbance. Extensive repairs were necessitated to put it in readiness for the campaign. The season was quite favorable with the exception of floods in May, which washed out some of the beets and made replanting necessary.

VISALIA.—A factory of 350 tons capacity was operated here this year for the first time by the Pacific Sugar Company. Beets were planted, in about even proportions, in January, February, and March. Considerable of the land was broken up by the aid of a traction plow turning over 40 acres per day.

The season was quite favorable, and considering the newness of the district in growing sugar beets, a good yield and quality of beets was secured where farmers gave heed to the directions of the agricultural superintendent.

Some damage was done to machinery in transit by the earthquake at San Francisco.

It is the purpose of the management of the factory to try the availability of a large traction engine for beet delivery. Experiments indicated that this might be desirable with the roads in fine condition.

On account of the very early planting of some of the beets and the lateness of starting the campaign, many of the beets became too ripe and stayed in the ground too long, lowering the purity and causing considerable loss of beets. As a rule, beets marketed and tested at the proper times indicated high quality, purity, and a good yield.

On account of the newness of the district and the misfortunes met by the factory, it was required to close down on several occasions, thus extending the time of the campaign. The district had consider-

able difficulty in securing labor, both in the field and factory. These are things often encountered by new factories, and as a rule they are remedied by the beginning of the second campaign.

COLORADO.

One of the most interesting States engaging in the beet-sugar industry is Colorado. Here the influence of this industry in developing the resources of a State can be studied better than in any other place in our country. From its inception improvement has been very rapid; progress and development of business interests has been incessant. In most instances factories have been located in small towns. The upbuilding of business at these centers has been remarkable.

In all parts of the State where crops are grown irrigation is necessary. Draining the Rocky Mountains toward the east are two rivers—the Platte and, farther south, the Arkansas. In Colorado along the Platte River, from which beets and other crops are irrigated, are located 9 sugar factories. Along the Arkansas River there are 5. The results of these factories have been something remarkable, not only in the production of sugar, but in the general development of agriculture and business.

In the western part of the State is the Grand River, flowing westward. Upon this, in Mesa County, is located the sugar factory at Grand Junction, and beets grown for this factory are irrigated from it. Near the Platte River and near together, in the western part of Weld County, are 3 large sugar factories—at Greeley, Eaton, and New Windsor. In the eastern part of Larimer County, adjoining Weld, are 2 sugar factories—at Fort Collins and Loveland, respectively. Near these factories, in the northeast corner of Boulder County, is another sugar factory—at Longmont. Thus we find a group of factories around the one at New Windsor at distances ranging from 12 to 25 miles. These factories are all substantially built, modern, and equipped with the best machinery.

In this district are a great many reservoir lakes, which are filled in the spring from the melting snows in the Rockies. They are used for storage of water for use on crops during the growing months.

In rotation with sugar beets are grown wheat, potatoes, alfalfa, barley, and some other crops. The soil is very productive of any of these, and good lands are worth from $150 to $300 per acre. The towns at which these factories are located are now all live, up-to-date, active business centers. The amount of money annually pouring into these localities so near together gives to this part of the State a very prosperous and interesting aspect.

Eighty miles east of Greeley, along the Platte River, is located, at Fort Morgan, another sugar factory, and on the same river, 12

miles farther east, is located a factory at Brush, both of these being in Morgan County. About 50 miles farther east, on the Platte River, is another factory at Sterling, completing the present system of sugar factories on the Platte River.

On the Arkansas River, at Rocky Ford, in Otero County, is located one of the largest and the second factory built in the State. About 5 miles east of Rocky Ford, at Swink, in Otero County, is another sugar factory. About 17 miles north, on the Missouri Pacific, in Otero County, is the Sugar City factory. About 50 miles east of Swink, on the Arkansas River, is a factory at Lamar, and 30 miles east of that, on the eastern edge of the State, on the Arkansas River, is a factory at Holly. Both the last-named factories are in Prowers County. This completes the Arkansas River factory system.

This gives the State of Colorado 15 sugar factories. No other industry has done so much to develop its agricultural resources. It is estimated that during the last year these beet districts in Colorado produced nearly 1,500,000 tons of beets, worth $7,500,000. They have been the direct cause of building several local transportation lines reaching out into the agricultural districts, hauling the sugar beets to the factory and other products to the main lines.

Their influence on the live-stock industry has been marked. Alfalfa, small grain, and the pulp from the sugar factories make a ration adapted to fattening cattle and to feeding dairy animals. When the State of Colorado first engaged in beet-sugar production it had very little information regarding methods and utilities incident to the beet crop. At first very little use was made of the by-products. Most of the pulp and molasses were thrown away. Now the pulp is contracted for in advance of its production at 50 cents per ton. Arrangements are under way for establishing a distilling plant to produce denatured alcohol from the waste molasses.

Outside the general demand from large feeding interests in these factory districts, the factories themselves have built extensive feeding pens for fattening large bunches of cattle and sheep. In the area tributary to the six factories in Weld, Larimer, and Boulder counties several hundred thousand lambs are annually fattened by the feeders and factory managements. According to the estimated production of beets in Colorado for 1906 the output of pulp would be 750,000 tons. This, valued at 50 cents per ton, the regular market price, would equal $375,000.

For a few years these factory managements had difficulty in securing sufficient beets to run full campaigns. This is now changed. Beet production has become so popular that the serious problem during the past season was to dispose of all the beets presented. Even at the rapid rate factory building has proceeded in the State it has outstripped the State's capacity for manufacturing sugar. When the

first factory was built at Grand Junction the difficulty of securing sufficient beets to run the factory became so intense that it was necessary to close it for a couple of years. This year this factory had as many beets as it could practically work. How to utilize the beet-producing area developed is becoming a serious problem with most of the factories. Now that the farmers are better advised on beet production and realize more fully the benefits of the sugar factory and crop, the tendency in beet districts is to overproduction. The factory managements realize this and appreciate the necessity of more plants. At the present time there are some economic conditions causing capital to hesitate about making such large investments as are required by sugar factories. The beet growers seem prepared to furnish beets in abundance to meet the demands of a very rapid increase in factory building.

For some time the price of beets has been $5 per ton flat. At the close of the 1906 campaign the Great Western Sugar Company proposed a new conditional two-clause elective contract. This provided that—

First. The farmer could elect to deliver all his beets as soon as harvested, for which he would be paid $4.75 per ton flat.

Second. He could elect to silo one-fourth of his crop and deliver the rest as soon as harvested. For the part delivered immediately he would receive $5 per ton flat, for the part siloed and delivered in winter he would receive $5.50 per ton flat.

Beet deliveries at most of these factories have been so large, so much beyond their storage capacities, that a great deal of difficulty has been encountered. It became necessary to pile the beets in heaps on the factory grounds and along the railroads in the country. Before these beets could be reached they were frozen, many of them thawed, and considerable loss was incurred in inversion of sugar and rotting of the beets.

This company, operating these 9 factories in Colorado, in offering this contract hoped to induce the farmers to silo a large portion of their beets, delivering them later, thus facilitating the operations of the plant and preserving the quality of the beets. In the northern part of the State the beet growers have organized a State beet growers' association. Through this association they are asking a flat price of $5 per ton and no siloing.

One of the bad effects of overproduction manifested itself this year. Near the middle of November occurred a very heavy storm, accompanied with snow and freezing. From 12 to 20 per cent of the beets grown for these factories were still in the ground. Quite large quantities of the beets had been harvested and were in piles in the fields, simply covered with beet leaves. These were frozen as

they lay. The factories engaged at once in working these, as beets are not damaged if they are worked before thawing. The hazard lay in the beets still in the ground. It is impossible to harvest beets when the ground is badly frozen, and if it remains permanently frozen the beets are lost. It is impossible for a factory to receive at once and store all of the beets grown for it. Most companies insist, before time for the ground to freeze, that beets not needed for the factory's run for a certain period shall be harvested and siloed, and in Colorado they offer 50 cents per ton extra for siloing. The Northern Beet Growers' Association, on the other hand, strongly objects to this extra work. With reference to this point there has been considerable negotiations between the two interests. In preference to a price based upon the sugar content and purity, the association further asks for a straight flat rate of $5 per ton. Undoubtedly these matters of controversy will eventually be amicably settled.

It may be said that the favorableness of the season, the better methods, and the past profits conspired to make the past year a record breaker in beet growing in Colorado. Nowhere was there heard any expressed regrets of factory managements on the lack of beets. Overproduction was the more familiar expression. The yield was very high and sugar contents and purity were excellent. In 1906 the sugar industry brought prosperity to everybody engaged in it.

BRUSH.—The Great Western Sugar Company operated a factory of 750 tons capacity during its first campaign this year. Beets grown for it were of good quality, and farmers as a rule secured good yields. Beets have been grown around this place to a considerable extent for several years. The factory was necessary to meet the demands of rapidly growing beet production.

EATON.—A factory of 600 tons capacity has been operated by the Great Western Sugar Company at this place for several years. Prior to beet growing the district was largely given to the production of potatoes and wheat. This factory is near to and associated with a number of others in that part of the State. In this district it may be said that beets are the leading agricultural product. The season was quite favorable. A large acreage was planted for the factory. It had an abundance of beets, and made a full campaign.

FORT COLLINS.—The Great Western Sugar Company is operating a factory at this place of 1,200 tons capacity. Weather conditions were favorable the past year, and farmers have become familiar with the crop. The large acreage planted resulted in what is generally called a "bumper" crop. Shortage of cars very much delayed the delivery of this large tonnage of beets. This was followed during the harvest by a serious snowstorm, lasting several days, freezing

many of the beets in the ground. All of this caused much inconvenience and considerable loss both to the farmers and factory management. It is from this district in Colorado the most serious objections to siloing come.

Throughout the district the yield of beets per acre was very large and the quality exceptionally good. The better qualification of the farmer to produce sugar beets in the older factory districts is the principal factor to which is due the increase in acreage and in yield per acre. He knows the soil requirements, the better methods of culture, and how to handle and economize labor. He gets better results and it costs him less, all of which tends to encourage him to produce the beets.

As an indication of the situation at Fort Collins this year, the results of beet growing, and the public's appreciation, I clip from the Denver Republican of December 18, 1906, the following:

> Since December 1 the Fort Collins sugar factory has paid out for sugar beets and for salaries and wages of employees over $400,000, and since the sugar campaign opened, on September 25, over $800,000. Another payment of beets will fall due January 15, when it is expected $200,000 more will be paid out, making over $1,000,000 which the factory will have put into circulation by that time.
>
> There are yet at least 40,000 tons of beets at the various dumps and in the fields to be delivered to the factory and the sugar-making campaign will probably not end before March 1.
>
> Chester Iddings, one of the successful farmers of the Cache La Poudre Valley, last spring planted 84 acres to sugar beets. He harvested his crop, 1,800 tons, and had it all delivered before December 1, and December 15 received a check for $9,000. His beets averaged 21.4 tons to the acre. Deducting $3,000 as the cost of producing the crop, he has $6,000 profit.

Larimer County, in which Fort Collins is located, is in one of the best developed agricultural sections of the State. In this county are two sugar factories, the other one being located at Loveland. I clip from the Fort Collins Express the following statement of crops produced, with their respective values:

Values of agricultural products of Larimer County, Colo.

Beets	$1,796,270
Wheat	360,000
Oats	98,000
Alfalfa	500,000
Berries	150,000
Fruits	75,000
Potatoes	125,000
Lamb feeding profit	225,000
Cattle profit	100,000
Total	3,429,270

FORT MORGAN.—This season for the first time the Great Western Sugar Company operated a factory of 600 tons capacity at this place. As is usually the case when factories operate the year they are built, it was late in beginning its campaign, the opening in this case being on December 15. Many of the beets grown here were shipped to the factories at Brush and Sterling. The acreage planted was 4,343. An excellent stand was secured. As in other districts in the State the season was very favorable, the yields ordinarily running from 15 to 25 tons per acre. The beets were of high quality. It may be said, considering this to be the first year, that the results of beet growing were exceptionally good.

On account of the delay in completing the factory the farmers were late with their harvest, and the storm and freezing spell caught more beets in the ground at this place than in any other district in the State.

GRAND JUNCTION.—The Western Sugar and Land Company is operating a factory here of 500 tons daily capacity. The past season's results of this factory are the best illustration of snatching success from absolute failure.

The first two years this factory operated, its campaigns were very short, the beets were of ordinary quality, and the yield was poor. It closed down for a couple of years. It was reorganized under a new management and operated under an entirely different plan. In order to insure itself a sufficient acreage of beets the company bought a large acreage of land. On this land beet growing was made the principal feature. It branched out to other towns in the Mesa Valley and secured contracts. About 5,000 acres were planted last spring. The season was exceptionally good and the results were very favorable to everybody concerned. This may be regarded the best year in the experience of this factory. With the farmers beet growing has become popular. Feeders consume all the pulp. The future of the factory is assured.

GREELEY.—The Great Western Sugar Company has been operating a factory of 800 tons capacity at this place for some time. In results of making sugar and growing beets this is one of the model beet-sugar plants in the State. The company secured a large beet acreage. On account of its capacity limit it was compelled to refuse contracts with a number of farmers. The tonnage produced was several thousand in excess of what the plant could use, and these were shipped to other factories near by. On account of the large supply of beets at its disposal the factory opened its campaign early—September 14. At this date the quality of the early beets was not excellent.

The factory at Greeley is near two other sugar factories in the same county—at Eaton and New Windsor, respectively.

From the Denver (Colo.) News of November 25, 1906, I take a brief summary of conditions in the section of the country where these sugar factories are located:

If the total crop is harvested, there will be paid out for beets at the Greeley, Eaton, and Windsor factories not less than $1,500,000, and an additional $250,000 for labor in the factories proper, not including about $400,000 paid out to beet tenders during the summer. This will mean a total of $2,150,000 distributed among the farmers and workingmen of the three towns during this campaign.

HOLLY.—The Holly Sugar Company operated a sugar factory here of 600 tons capacity. It is located in Prowers County, in the Arkansas Valley, near the eastern line of Colorado.

For several years a large acreage of beets has been grown here for the factory at Rocky Ford. The latter has so stimulated beet growing in the Arkansas Valley that three other factories have been constructed to take care of the supply of beets.

Six thousand acres of beets were planted. A good stand was secured. Taking everything into consideration the season was favorable. The yield and quality of the beets were excellent.

LAMAR.—The American Beet Sugar Company is operating a factory here of 400 tons capacity. This district has been growing beets for some time for the factory at Rocky Ford. The farming community began producing beets for this factory with practical experience.

Operated by the present owners, the machinery of this factory was formerly in the plant at Norfolk, Nebr.

Weather conditions in this district were ideal throughout the growing period of the beets. Delivery of beets was considerably impeded later on account of the snowstorms and freezing conditions prevalent throughout the State about the middle of November. The campaign opened September 24. The quality of the beets was fair, and the yield unusually good. A large acreage was planted. The plant secured sufficient beets to give it a long campaign.

LONGMONT.—The Great Western Sugar Company operates the factory here. The accredited capacity per diem of this factory is 1,200 tons. Through recent improvements it usually exceeds this by 150 to 300 tons.

In common with the rest of the northern Colorado districts, it experienced a very favorable season and 11,800 acres of beets were planted. The results of the harvest in the district show an average of 14 to 15 tons per acre, giving the factory a long campaign. At the time of the heavy snow and freeze—the middle of November—this district had about 10,000 tons of beets in the ground and 30,000 lying in piles undelivered.

To facilitate beet delivery a railroad has been built from Johnstown, Weld County, to Longmont. This gives the district excep-

tional facilities for shipping by rail. Its beet-growing area is now well supplied with railroad transportation facilities.

There are now fattening on the ground around this sugar factory 50,000 head of cattle and sheep.

This place affords a study of the revival of business of a community by the introduction of a sugar factory. When built, Longmont was an ordinary quiet town, without much business activity. In order to indicate the change in land values and business, I clip from the Boulder (Colo.) Cambra of Friday, December 7, the following statement:

> One million dollars is a low estimate of the money added to the wealth of Longmont annually by the establishment of the sugar factory. This immense sum goes into every avenue of trade and business, and every man, woman, and child is a beneficiary.
>
> The going wage for man with team and wagon is $6, and as high as $10 has been paid per diem.
>
> As an instance of the increase in land valuation, we may cite the following: A short time before the building of the sugar factory a quarter section of land near Longmont was sold for $60 an acre, on easy time payments—in fact, the land had gone begging for a purchaser. Within one year the entire tract changed hands at $125 per acre. In six months more 80 acres were sold at $250 per acre, and the balance in smaller tracts at $250 to $300 per acre. In another case 4,000 acres previously held at $40 per acre are valued to-day at $150 to $200, according to quality.

LOVELAND.—The Great Western Sugar Company is operating a factory at this place of 1,200 tons capacity. It was the first one built in the northern part of Colorado. It may be called the mother plant of the other 9 along the Platte River. From the beginning beet growing has proven profitable. Throughout its career it has received annually a sufficient supply of beets to maintain satisfactory campaigns.

As a part of the plant, railroads have been added penetrating a large beet-growing area. These are operated for the special purposes of this sugar plant, delivering to it raw material and carrying the finished product to the market. Probably no other sugar-producing plant in the United States has had a more continuously successful history than this one. For several years the district has produced considerably more beets than necessary for this plant. These have been shipped to other factories belonging to the company in the vicinity. At the time of the November storm the freeze caught about 25,000 tons in the ground, and the same amount harvested, piled on the ground, and lightly covered. For this factory about 15,000 acres were planted. On the whole, the season was considered favorable, the average yield being between 14 and 15 tons per acre and the beets running from 14 to 20 per cent of sugar.

NEW WINDSOR.—The Great Western Sugar Company is operating a factory here of 600 tons capacity. The district experienced the same generally favorable season as the other factories in northern Colorado, and produced a large tonnage.

One of the features of this factory is that most of the beets are hauled to the factory by wagon. Consequently it was not subject to the inconvenience occasioned by the dearth of cars at the time of the beet delivery.

Pulp is worth at this factory 50 cents a ton, and sheep and cattle are fed in the vicinity.

Laborers in the field are generally of German and Russian extraction, many of these renting small tracts for growing beets. Where the hand labor is contracted by the acre the usual price for weeding, bunching, thinning, hoeing, and hand work in the harvest is $20.

ROCKY FORD.—The American Beet Sugar Company has been operating at this place a factory with a capacity of 1,000 tons per day. The lands producing the beets are watered by irrigation from the Arkansas River. As a rule sufficient rain falls in the winter and spring to germinate the seed and start the beets to growing. The soil in this district is very productive. The principal crops are sugar beets, alfalfa, and melons. This is the home of the famous Rocky Ford cantaloupe. These are grown here, crated, and shipped to all parts of the country. The district has also developed a large industry in producing a high quality of melon seeds. The flavor and sweetness of the melons are known throughout the country. The beets produced are of the same high quality.

Good lands are worth from $150 to $300 per acre, depending upon their location and distance from shipping.

The season throughout was unusually favorable. The rainfall at the time of harvest was more than ordinary. This had a tendency to lower the quality of the beets worked in the early part of the campaign. Like Loveland, in the North, this factory in the South, on the Arkansas River, is the progenitor of the others along its course which have been installed to work the beets grown.

STERLING.—The Great Western Sugar Company is operating a factory here of 600 tons daily capacity. The season was unusually favorable. About 6,500 acres were planted. It is estimated that Sterling district produced 65,000 tons of beets, requiring a campaign of about four months. On account of lateness in completing the plant at Fort Morgan, a large tonnage was shipped from that point to Sterling for manufacture. This materially increased the length of the campaign of this plant. It is estimated that about 80,000 tons of beets were worked altogether.

SUGAR CITY.—The National Sugar Manufacturing Company is operating a factory of 500 tons capacity at this point. Beets are

grown on lands irrigated from the Arkansas River. The company has a ditch about 40 miles long connecting with that stream. This carries the water into a couple of natural lakes on the company's ground. These are used for storage. The acreage contracted for was 6,159. The season was favorable. Beet growing was unusually successful. This company owns about 12,000 acres of land. It feeds cattle extensively on a ration of pulp and alfalfa.

SWINK.—The Holly Construction Company operated a factory of 1,200 tons capacity at this place for the first time this year. It is located on the Arkansas River a few miles east of Rocky Ford. Its establishment resulted from the large area worked up in growing beets by the factory at Rocky Ford. It is estimated that 8,220 acres were planted. The rainfall was sufficient to germinate the beet seed and start the plants to a healthful growth. The season throughout was favorable.

IDAHO.

Idaho is rapidly developing its agricultural resources. For several years in my annual reports I have been calling attention to its natural adaptation to agricultural industry. Primarily its soil is very fertile. It sustains a large crop list. It has an excellent climate, and vegetation grows thriftily and is usually of splendid quality. Most of the deciduous fruits produce in this State bountifully. It is especially adapted to high-grade apples and pears. Fruit takes on a rich coloring and a fine flavor.

As in the State of Colorado, cropping is dependent largely upon irrigation. Flowing through the State of Idaho from east to west and, to a considerable extent, up its western border is the great Snake River. Along the borders of this river are some very beautiful fertile valleys. It passes across the lower quarter of the State in the form of a crescent, with the bow to the south. It then passes up the western border for a considerable distance. The principal railroads follow this water course. There are other short stub lines reaching out from it either way, tapping rich agricultural districts. Running into this river, draining the mountains of its central area, are a number of other streams, the whole forming a system from which an abundance of water can be supplied for irrigating large tracts of land. For several years the various interests of the State and writers for the press have been calling attention to the State's natural agricultural resources.

Four years ago a sugar factory was introduced in the eastern part of the State, at Idaho Falls, on Snake River. This was the signal for a rapid development along the entire length. Many schemes of irrigation and internal improvement looking to facilities for utilization of the soil in crop production began to materialize. Tests made

in the State by those interested in the sugar industry revealed wonderful capabilities.

Not far north from this another factory was soon built, near St. Anthony, in Fremont County, at a small point called "Sugar." The year after this another one was started—a near neighbor of the first—at Blackfoot, in the same county, Bingham. Last year a factory was built at Nampa, in Canyon County, near the western border of the State. At the time this factory was established the sugar company agreed to build another at Payette, on the Snake River, in the northern and western part of Canyon County. So rapidly has beet growing developed in this district that this locality is now ready to furnish the acreage, and it seems settled that a factory will be erected at this place in 1907 or 1908. It may be said that there is hardly a well-developed agricultural district in the State that is not being considered for future beet-sugar production.

Since the inauguration of the sugar industry, development of irrigation and transportation facilities has followed in the State very rapidly. Around it hinges most of the plans which are materializing such effective and rapid results in the State. Since the building of the sugar plant at Nampa, which is located near Boise, the rapid development taking place in the territory represented by these towns has attracted the attention of the Reclamation Service of the Department of the Interior. It is now constructing what is known as the Boise-Payette irrigation project, at a cost of $7,000,000. When this project is completed it will water 300,000 acres of fertile land. Before it was started a large part of the area to be covered by its ditches was simply desert, upon which nothing grew but the sagebrush and kindred plants. With the prospects in view settlers are pouring into that section and rapidly developing all kinds of business. By the time the Government ditch is completed it will be one of the most closely settled, active agricultural districts in the State.

For years this State has sustained on its range millions of sheep, cattle, and horses. With the building of the ditch and the development of cultivated lands growing alfalfa and small grain, this stock is now being fed for market in the neighborhood of the sugar factories upon these home-grown feeds, mixed with a ration of pulp. It may be said that in the four years, from simply a stock-range State, Idaho has developed conditions sustaining all the features of animal industry from breeding to finishing for market.

All this State has ever needed to bring about this condition is irrigation. Water it had in abundance, flowing down its streams from the snows collected in winter and melting in summer. It has needed some stimulus to bring together the capital and business talent for installing irrigation systems. The instrumentality which has

largely accomplished this is the sugar factory. The State of Idaho is fast taking its proper place as an agricultural State.

It may be said that beet-sugar production in Idaho is entirely due to results of this industry in Utah, as all of the sugar factories operating in that State are under the management of the two companies operating factories in Utah.

The Deseret News (Salt Lake City) of December 15, from data obtained from the sugar companies, published a summary presenting the status of the beet-sugar industry in the State of Idaho. Coming from this paper it carries more than usual authority, and it is based largely upon actual, rather than estimated, results for 1906. It gives an idea of the importance this industry is assuming in that State. The estimate follows:

General results of the beet-sugar industry in Idaho in 1906.

Total acreage	acres	20,000
Total tonnage	tons	230,000
Average yield per acre	do	11.14
Total capital invested		$4,500,000
Total money paid farmers for beets		$1,100,000
Total money paid factory labor		$260,000
Output of sugar. (See table below)	pounds	64,000,000
Value of refined sugar, at 4½ cents per pound		$2,880,000

Estimated results of operation of Idaho factories in 1906.

Name and location.	Estimated product of sugar.	Estimated length of campaign.	Number of factory employees.	Number of farmers growing beets.
	Pounds.	*Days.*		
The Idaho Sugar Company, Sugar City	23,000,000	115	200	500
The Idaho Sugar Company, Idaho Falls	20,000,000	90	160	450
Snake River Beet Sugar Company, Blackfoot[a]	10,000,000	85	140	200
Western Idaho Sugar Company, Nampa	11,000,000	75	160	300
Total	64,000,000	.....	660	1,450

[a] The Blackfoot factory will work about 15,000 tons of beets diverted from the Sugar City and Idaho Falls plants.

The last session of the National Irrigation Congress was held at Boise, Idaho, September 3 to 8, 1906. One of the chief features of interest at this meeting was a sugar-beet prize contest. The Great Western Sugar Company, of Denver, Colo., operating 9 factories, offered a prize costing $500 to the beet grower presenting the highest grade beets. The date of this contest was a little early for beets grown in the intermountain States, from which most of the samples came. It may be stated, however, that all the samples presented, considering the time, indicated very high quality. The contest was open to individuals, firms, corporations, organizations, counties, and States.

Regarding the results of this contest, M. B. Gwinn, of Boise, Idaho, has the following to say:

BOISE, IDAHO, *January 7, 1907.*

DEAR SIR: I inclose you herewith a copy of the report made by the chemists and the committee making the awards, which I trust contains the information desired.

The loving cup donation by the Great Western Sugar Company was awarded to the State of Idaho on the beets raised and exhibited by Mr. C. Nofsinger, of Nampa, Idaho.

Very truly, yours, M. B. GWINN.

The following are the rules governing the contest:

The samples shall consist of 5 beets of an average weight of not less than 1 pound each, not more than 4 pounds each, accompanied by tag giving name and address of grower and kinds of seed, also date of planting (if possible).

The samples of beets examined by the judges shall be turned over to the chemists for analysis after the judges have recorded in a book the names and addresses of the growers, giving each sample a number, which shall be entered in the judges' book as a record. The chemists, after determining the percentage of sugar and the purity of each sample, using the methods employed by first-class sugar factories, shall record the result on a field sample slip, attaching the same to the grower's sample slip, and shall record the results on a field laboratory sheet, giving name of grower, the date of sample, the average weight, the brix per cent sugar in the juice, the per cent of sugar in the beet, the purity, and any other information that may be found upon the grower's sample slip or otherwise discovered by the chemist, and shall return the slips, together with the report sheets, to the judges, furnishing duplicate sheets containing the above information to the board of control immediately after the completion of the work.

The basis upon which the prize shall be awarded is as follows:

	Points.
For perfection in shape, not to exceed	10
For 14 per cent of sugar in the beet	25
For every additional 1 per cent of sugar (with a proportionate amount for every fraction thereof)	4
For a purity of 80	25
For every additional point of purity (with a proportionate amount for every fraction thereof)	3

In the table below will be found the names of the exhibitors, the number designating each, the weight, the brix degrees, polarization of sugar in the juice, purity coefficients of the beets, and grade number designating form.

List of analyses covering beet exhibit at the Boise Irrigation Congress, 1906.

Name.	Record No.	Weight.	° Brix.	Polarization.	Per cent of sugar.	Coefficient of purity.	Form.	District.
		Lbs. ozs.						
Gibson & Hunt	10	2- 3	18.7	15.9	14.7	85.0	9.0	Nyssa, Oreg.
A. J. Quackenbush	11	1-12	17.8	14.6	13.5	82.0	7.25	Ontario, Oreg.
R. Mulder	12	2- 0	19.5	16.6	15.4	85.1	7.5	Do.
James Walters	13	2- 2	17.6	15.0	13.9	87.0	7.5	Do.
F. W. Sheffield	14	2- 8	19.5	16.2	15.0	82.8	8.0	Nyssa, Oreg.
K. S. & D. Ranch	16	2- 5	17.3	13.7	12.7	79.2	7.0	Ontario, Oreg.
C. E. Annidon	17	1-15	18.2	15.8	14.6	86.8	7.5	Do.
C. J. Beckwith	18	3- 3	21.4	18.6	17.2	86.7	8.0	Payette, Idaho.
Geo. Mordhurst	19	2- 9	19.1	14.5	13.4	75.7	8 33	Do.
Peter Pierce	20	3- 4	19.1	16.3	15.1	85.4	7.5	Do.
E. C. Brainard	21	2- 8	19.1	16.0	14.8	83.8	8.33	Do.
H. N. Lewis & Son	22	3- 1	19.3	16.4	15.2	84 9	7.25	Do.
J. A. White	23	2-11	19.1	16.3	15.1	85.1	9.0	Do.
John Barch	24	2-15	18.8	15.9	14.7	84.3	8.0	Do.
C. C. Eiffe	25	2-12	19.0	15.9	14.7	83.7	7.0	Do.
A. L. Tuttle	26	2-11	19.8	16.5	15.3	83 3	7.5	Do.
James Hutchinson	27	2- 5	21.0	17.8	16 5	84.8	7.25	Do.
Henry Irvin	28	2- 2	21.0	18.1	16.7	86.0	8.0	Do.
E. Bloomstrom	29	3- 5	19.7	17.0	15.7	86.3	7.25	Do.
Frank Roberts	30	3-11	18.3	15.1	14.0	82.1	9.0	Do.
C. E. Harry	31	2- 4	20.3	17.2	15.9	84.7	7.0	Do.

List of analyses covering beet exhibit at the Boise Irrigation Congress, 1906—Continued.

Name.	Record No.	Weight.	° Brix.	Polarization.	Per cent of sugar.	Coefficient of purity.	Form.	District.
		Lbs. ozs.						
McOmie & Albert	32	2- 1	19.4	16.0	14.8	82.5	7.0	Payette, Idaho.
W. McConnell	33	3- 3	18.7	15.0	13.9	80.2	6.75	Do.
H. C. Precht	34	1- 6	19.4	16.5	15.3	85.0	6.75	Do.
H. Cornulson	35	2-12	19.2	16.2	15.0	84.4	6.25	Do.
B. H. Woods	37	3- 0	18.3	15.3	15.1	83.3	7.25	Do.
Wm. Winters	38	1-13	18.4	15.2	14.1	82.6	7.0	Do.
John Anderson	39	2- 1	21.0	18.1	16.7	86.2	8.0	Do.
Jesse Graham	40	1-13	20.7	17.3	16.0	83.3	8.0	Do.
O. H. Bushnell	41	1-14	20.9	18.0	16.7	86.1	7.5	Do.
E. E. Hunter	42	1-13	19.4	16.8	15.5	86.3	8.5	Do.
L. Johnson	43	2-12	17.5	14.7	13.6	84.0	8.25	Do.
B. Shonts	44	2- 5	21.8	17.7	16.4	81.2	7.0	Do.
Guy Graham	45	2- 5	21.7	18.5	17.1	85.3	7.25	Do.
J. Bowers	46	2- 5	18.6	15.7	14.5	84.4	7.5	Do.
J. L. Goeller	47	2- 0	20.1	17.2	15.9	85.6	7.5	Do.
Walter Meade	48	2- 9	19.2	16.4	15.2	85.2	8.0	Do.
O. B. Ficht	49	1-14	20.0	17.0	15.7	84.8	7.5	Do.
W. F. Howard	50	2- 7	20.3	16.4	15.2	80.8	6.5	Roswell, Idaho.
Geo. H. Brush	51	3- 2	19.5	16.4	15.2	80.0	5.0	Do.
W. H. Ross	52	3- 9	19.5	16.4	15.2	83.9	4.5	Do.
J. H. Trout	53	3-13	17.7	14.4	13.3	81.4	4.0	Do.
L. M. Birch	54	2-14	18.1	14.4	13.3	79.6	5.0	Do.
S. Hill	55	3-14	19.2	16.3	15.1	84.9	4.0	Do.
Frank Johns	56	2- 8	20.7	17.1	15.8	82.6	3.75	Do.
James Crills	57	1-11	19.6	16.7	15.5	85.2	6.5	Nampa, Idaho.
G. D. Ficke	58	1-13	19.4	16.8	15.5	86.3	4.5	Do.
A. Moreland	59	1- 8	19.7	17.0	15.7	86.3	5.0	Meridian, Idaho.
John Berry	60	1-11	19.8	16.6	15.4	83.8	5.0	Do.
I. Yant	61	1- 7	19.8	17.2	15.9	86.9	5.0	Nampa, Idaho.
C. Nofsinger[a]	62	1-13	20.3	18.0	16.6	88.7	5.0	Do.
A. Mickels	63	1- 8	19.0	16.5	15.3	86.9	4.5	Do.
John Halton	64	1-11	21.1	17.5	16.2	87.1	4.75	Do.
Tolef Olson	65	2- 2	19.5	17.1	15.8	87.4	5.25	Do.
J. Brent	66	2- 3	19.2	16.8	15.5	87.5	5.5	Do.
Kate Greene	67	1-10	19.0	16.6	15.4	87.1	5.5	Do.
T. N. Beckner	68	2- 0	17.9	14.7	13.6	82.1	7.0	Do.
Geo. Duval	69	1-10	20.8	17.6	15.3	84.6	6.5	Do.
John Nelson	70	2-15	19.4	16.0	14.8	82.5	6.0	Parma, Idaho.
Chas. Metcalf	71	3- 3	18.8	15.6	14.4	83.0	4.25	Caldwell, Idaho.
N. S. Miller	72	2- 3	17.6	14.5	13.4	81.5	5.0	Do.
A. H. Smith	73	3- 3	18.1	14.3	13.7	81.8	6.5	Boise, Idaho.
A. F. Loveland	74	1-10	18.4	15.9	14.7	86.4	8.5	Deweyville, Utah
Alva Rhodes	75	1- 4	17.8	15.7	14.5	88.2	8.5	Garland, Utah.
John Ward	76	1-12	19.0	15.9	14.7	83.4	7.75	Nyssa, Oreg.
G. W. Jenkins	77	1-10	19.6	16.9	15.6	86.0	7.5	Ontario, Oreg.
Peter Jensen	78	1- 7	20.2	17.2	15.9	85.2	7.5	Nyssa, Oreg.
John Ray	79	2-11	20.1	17.5	16.2	87.1	8.0	Do.
Ennis & Heasie	80	2- 3	20.1	17.3	16.0	86.1	8.0	Do.
A. A. Brown	81	2- 2	20.4	17.7	16.4	86.5	8.33	Ontario, Oreg.
Utah Sugar Co	82	1-11	18.9	15.9	14.7	84.1	8.0	Garland, Utah.
Ed Velberg	83	2- 0	19.6	17.0	15.7	86.7	8.25	Emmett, Idaho.
Alex Pherson	84	2-13	18.5	15.2	14.1	82.2	8.0	Twin Falls, Idaho

[a] Score on Mr. Nofsinger's sample which won the prize was 91.5 points.

BLACKFOOT.—The Idaho Sugar Company is operating a factory at this place of 600 tons capacity. This factory was formerly located at Binghamton, N. Y. Sugar beets grown for it in the East were brought into such close competition with specialized crops that it was decided to move it to this point.

One of the features playing no little part in factory building in recent years is the effect of such an establishment on the values of western cheap lands. Under natural conditions such lands are only valuable for grazing. Give them a sugar factory and an irrigation ditch and their value becomes very much augmented. The main object in establishing many of the factories built in these mountain States is the enhancement of resources and land values of the dis-

trict. This was largely the cause of the removal of this plant to this place.

During its first year, before irrigation had been sufficiently developed, the district surrounding Blackfoot suffered a severe drought, and the beets were more or less affected by blight. During its second year the beets were attacked by an insect pest, and considerable loss of crops resulted in Idaho and Utah on this account. Since its removal here until the present season it may be said that the factory has not been specially encouraged. The past season was quite favorable, and, in addition to beets grown in its vicinity, it received a large number from the overplus grown around Sugar City and Idaho Falls, not far from it. From the results this year the farmers seem greatly encouraged. The prospect is that it will have a large acreage planted next year. On account of the better irrigation facilities and experience gained by the farmers during the past three years the factory seems destined to have a successful future.

Twenty-five thousand tons of beets were grown in this vicinity. From a local newspaper I clip some results of beet growing in the vicinity of Blackfoot during the past season, as follows:

O. J. Cobbley, Riverside, 30 acres; average yield, 15 tons per acre.
G. A. Powell, Blackfoot, 18 acres; average yield, 18 tons per acre.
A Whitton, Wapello, 40 acres; average yield, 15 tons per acre.
J. T. Woodland, Blackfoot, 32 acres; average yield, 16 tons per acre.
William Moore, Basalt, 11 acres; average yield, 15 tons per acre.
J. F. Jensen, Basalt, 15 acres; average yield, 17 tons per acre.
N. Sorensen, Groveland, 16 acres; average yield, 17 tons per acre.

IDAHO FALLS.—The Idaho Sugar Company is operating a factory here of 1,200 tons capacity. This was the first sugar factory established in the State, and from its results other companies were encouraged to build.

Weather conditions in the district in the early part of the growing season were rather unfavorable. There was an unusual amount of rainfall, and the water standing on the ground from overflows, followed by hot sunshine, caused many of the beets to scald and rot. Taking everything into consideration, the season may be counted favorable, and results were fairly encouraging. A clipping from a local paper gives some of the better results of beet growing in the district during the past season:

Best results of beet growing around Idaho Falls, Idaho, in 1906.

Name.	Area harvested.	Yield of beets.	
		Total.	Per acre.
	Acres.	*Tons.*	*Tons.*
C. W. Rockwood, Iona	50	855.27	17.10
T. C. Barlow, Iona	55	990.39	17.10
H. Bowman, Iona	22	442.18	20.09
C. C. Randall, Grant	10	184.30	18.43
C. J. Call, Rigby	5	119.55	23.93
Woodhouse-Gaddie, Idaho Falls	140	2,478.30	17.50
J. C. Jensen's farm, Idaho Falls (operated by Idaho Sugar Co.)	220	3,316.56	15.07

NAMPA.—For its first campaign at this place the past year the Western Idaho Sugar Company operated a factory of 750 tons capacity. The builders were under contract to have it in readiness by September 1. It was presented to the company on time, probably the first instance of the kind in the history of factory building in the United States.

The season was quite favorable. Considering that this was the first campaign, with the usual obstacles to be encountered under such circumstances, the results were more than usually favorable. The average tonnage was large, and the beets throughout the run maintained a high quality. So encouraging was the first campaign that farmers are pressing eagerly for contracts, and the indications are that the factory will receive an abundance of beets for its second campaign. From a local paper I clip some of the better results of beet growing in the district during the season:

Results of beet growing around Nampa, Idaho, in 1906.

NAMPA DISTRICT.

Name of grower.	Acreage.	Tons per acre.	Name of grower.	Acreage.	Tons per acre.
Mrs. Kate Green	48	14	C. G. Nofziger	18	16
Mrs. Kate Green	10	14	T. M. Beckner	32	15
Geo. Duval	100	16	J. Herman	12	22½
Geo. Duval	26	21½			

BOISE DISTRICT.

J. Keener	17	13	R. H. McNiel	5	20

MERIDIAN DISTRICT.

C. E. Madden	9	14	Robert Noble	12	14
D. Washam	5	22			

PAYETTE DISTRICT.

Henry Ervin	41	16	H. Mason	7½	24
E. E. Hunter	20	22	J. Hill	20	20
McOmie & Albert	31	18			

WEISER DISTRICT.

Peter Pence	31	17	O. W. Baker	15	17
V. Bowers	11	16½			

ONTARIO DISTRICT.

John Ray	10	28	A. J. Quackenbush	20	27
F. W. Sheffield	28	22			

NYASSA DISTRICT.

Gibson & Hunt	30	22			

SUGAR.—The Idaho Sugar Company is operating a factory here of 1,200 tons capacity. This was its third campaign. With experience farmers have improved very much in methods, and beet growing has been much more satisfactory.

It may be said that the weather throughout most of the growing season was ideal. A large acreage was planted. The stand secured was better than usual. The weather continued favorable up to the time of harvest. The beets were larger, and the average tonnage per acre was better than during any other season in the factory's history. I clip from a local paper some results of beet production in this district during this season, as follows:

Results of beet growing around Sugar, Idaho, in 1906.

Name and address of grower.	Area harvested.	Yield per acre.	Name and address of grower.	Area harvested.	Yield per acre.
	Acres.	*Tons.*		*Acres.*	*Tons.*
John Ricks, Sugar	8	16	E. A. Lenroot, Archer	15	18
W. E. Hunter, Parker	22	17	H. C. Robison, Lyman	15	18
H. H. Hunter, Parker	13	18	Theo. Simmons, Lyman	4	16
A. D. Miller, Parker	15	20	H. B. Simmons, Lyman	4	15
D. E. Miller, Parker	20	16	Ed Runnell, Archer	10	20
Wm. Flint, Parker	15	21	Mark Austin, Sugar	20	21
H. S. Jackson, Parker	10	17	L. Thomas (boy of 12), Sugar	1¼	26
W. Baker, Sugar	10	16	Alma Lusk (boy), Sugar	1	30
Reuben and Lee Austin, Sugar			J. Freer, St. Anthony	10	18
J. E. Bigley	15	20	J. Slack, St. Anthony	10	18
James Siddoway, Teton	20	18	E. B. and S. Farm, Sugar	300	15
Mrs. H. Grover, Parker	11	17	J. L. Evans, Rexburg	29	17
Jacob Johnston, Teton	10	18	Eph Ricks, Sugar	13	20
Jesse M. Baker, Teton	20	16	A. J. Hansen, Sugar	5	26

ILLINOIS.

From the inception of the beet-sugar industry there has been considerable agitation in the northern half of the State of Illinois in favor of its introduction. On account of the excellent railroad facilities, large markets, and their availability the State's commercial conditions are especially favorable for this industry.

As in other States east of the Mississippi, capitalists have been inclined to take a conservative stand in regard to investment in sugar factories. Farmers, as a rule, are well satisfied with present crops. There is a wide variety of crops, the soil is productive, and market facilities are excellent. The principal products are corn, cattle, hogs, horses, milk and butter, poultry and eggs. These lines of production have been long established and have proven profitable; consequently the farmers are wedded to them and hesitate to change to something else. As lands are already very high not so much increase in value can be anticipated from the establishment of the sugar industry as in States farther west, where it receives more encouragement at present.

Nearly all of the northern half of the State has agricultural, climatic, and commercial conditions adapted to the industry. The people of many localities have, from time to time, exhibited con-

siderable interest in the matter. It seems inevitable that, with the rise of land values in the West, the State will eventually engage in the sugar industry to a considerable extent.

RIVERDALE.—A small factory of 350 tons capacity, under the ownership of Charles Pope, of Chicago, is now operating at this place, a small town a few miles south of Chicago.

When the facts are better appreciated the results of this factory will be accepted as evidence of the industry's ability to meet competition with well-established crops.

Riverdale is near the town of Harvey, Ill. Around this place for several years were grown from 600 to 1,200 acres of beets for a factory at Kalamazoo, Mich. The yield and quality of beets were both generally good. A number of farmers got an insight into the profits and benefits of beet production. This suggested the building of this small factory at Riverdale. Naturally, under more conservative sentiment prevailing, the progress of such a plant would be slower than that in a new developing district of the West, where crop resources are limited and agricultural development is based largely upon the work of the sugar factory.

Agricultural conditions were generally favorable to the crop at this place during the past season, though it was rather dry during August and rather wet during the early harvest. The acreage secured was not large, but it considerably exceeded that of last year. In comparison with other crops, the beet crop gave very favorable results. The plant is slowly gaining a permanent place in the agricultural industry of the section. In connection with the factory a new beet-pulp drying plant was installed.

KANSAS.

Beet production and sugar manufacture have been under active consideration in many parts of Kansas since the inception of the industry in the United States. The western part of the State, along the Arkansas River, has conditions quite similar to those prevailing in eastern Colorado where beets are grown.

Several years ago the legislature passed a bounty law, offering $1 per ton for beets grown in the State from which sugar was actually made.

Considerable acreage has been grown for several years around Garden City, in Finney County; Deerfield and Lakin, in Kearney County, and at other near-by points. These beets were sold to the factory at Rocky Ford, Colo., and the bounty was collected from the State of Kansas. As a result of this development work a beet-growing district was thoroughly established in these localities in Kansas. These beets, with sufficient moisture, generally returned good yields of excellent quality.

GARDEN CITY.—During the past season a sugar factory of 1,000 tons capacity was constructed and operated at this place by the United States Sugar and Land Company. In its establishment occurs one of the remarkable instances of the general development to which I have often referred. The company, prior to building this plant, purchased 27,000 acres of land in Kearney and Finney counties. It purposes building three or four other factories as fast as conditions for furnishing a competent supply of beets will permit. This large land holding by the company has in view two purposes: (1) It gives the company an absolute assurance of sufficient acreage of beets to supply the sugar factories for campaigns of reasonable length; (2) it is inevitable that these factories will so develop agricultural conditions that the value of the lands will be greatly enhanced.

Covering these lands the company owns about 300 miles of irrigation ditches. Most of these had been formerly in use. They had been in the hands of a receiver, had been neglected, were out of repair, and doing the service for which they were intended very poorly. Under the new incentive furnished by the sugar factory this year these ditches were all cleaned out and freed from plant growth and other débris, new laterals were made, and the whole system was put in first-class condition. For some time tests have developed a large supply of underlying sheet water, which led many farmers to put in gasoline pumping engines and open up ditches for private use. The United States Government, under the reclamation act, established a pumping irrigation system costing about $260,000. The whole district took on new life and became busy.

The company leases its lands on shares in 80-acre tracts. On these tracts the tenant must plant and care for a specified number of trees furnished by the company. He must raise not less than 20 acres of sugar beets, one-sixth of the yield going to the company; also, one-third of the small fruit, one-half of the alfalfa, one-eighth of the melons, and one-half of the grain crop go to the company. The company builds for each tenant a four-room house and sheds and barn for cows and two teams, and puts in windmills or pumps sufficient to irrigate the cultivated lands.

The main ditch established by the Reclamation Service runs from Deerfield to Garden City. The pumping plant is located near Deerfield, and transmits power to 24 pumping stations, 12 on each side of the river. Each will draw water from 10 wells. The water pumped on the south side of the river will be conducted through a siphon to the flume on the north side. Farmers receiving the benefit of this Government plant are to reimburse the Government in 10 annual payments.

The company owning the sugar plant is also building storage reservoirs for holding flood waters coming down the Arkansas River in the spring. Such gigantic improvements have thoroughly aroused public interest. On the date of the opening of the United States Sugar and Land Company's plant excursion trains were run, bringing in several thousand people to witness and celebrate the inauguration of the first beet-sugar plant in the State. At its opening the governor of the State delivered the formal address. This indicates the popular estimate of the benefits of this industry.

About 6,500 acres were planted to beets. Weather conditions in the spring and early summer were quite favorable, with a tendency toward excessive rains at harvest time. The tonnage and quality of the beets were highly satisfactory.

The factory was completed and in readiness for the campaign earlier, but on account of excessive rains falling at this time the harvest was delayed and the campaign of the factory opened October 10. Tests of beets at the beginning showed an average of over 16 per cent of sugar.

MICHIGAN.

The progress of the beet-sugar industry in Michigan has been somewhat erratic. While more factories have been built than in any other State, general results have been less favorable. The State has many natural advantages, but there are some drawbacks. In the spring, about the time of planting and germination of the seed or of bunching and thinning, there is likely to be wet, cold, muddy weather. This destroys or weakens the germs, lessening the stand; promotes grass and weed growth; interferes with the work of bunching and thinning, and allows the beets to become foul, requiring extra labor and expense in cleaning fields. Frequently, owing to excessive rains in the latter part of September and during October, the fields become soft. This lowers the quality of the beets, retards the harvest, and results in bad roads, materially increasing the labor and expense of harvesting and delivery of beets.

The obstacles presented to the beet-sugar industry in this State have been very serious. Most of the factories have been compelled to operate short campaigns. Six have been driven out of business, dismantled, and moved to other sections of the country. Those continuing to produce sugar have gradually developed more favorable conditions. It may be said that the remaining Michigan factories have become fairly prosperous and assured of a career of usefulness. The cost of producing beets is considerably less than it was formerly. Campaigns are much longer. The economies are better appreciated. Originally most of the factories were compelled to throw away all their pulp. They not only lost the entire proceeds of a valuable by-

product, but were at the expense of removing it. In a State like Michigan—near large markets, adapted to dairying, feeding, and breeding—the factory should receive for its pulp at least $1 per ton. Each ton of beets costing $5 produces half a ton of pulp worth 50 cents. The pulp produced is equal in value to 10 per cent of the amount paid for beets for the sugar factory. The extravagance of throwing it away in Michigan can readily be appreciated. Yet the factories were compelled to do this. The conditions, however, are rapidly changing. Farmers appreciate more generally the value of this by-product for feeding, and many of them are now consumers. Several of the factories in Michigan have installed in their sugar plants processes for drying the pulp, thus eliminating 80 to 90 per cent of its weight. This furnishes a feeding product readily transportable to all parts of the country. In a short time the entire output of pulp in this State will be utilized at $1 per ton and will either be consumed locally or dried and shipped to market. This means a saving to the factory equivalent to 10 per cent of the entire value of the beets it purchases.

Rapid changes are taking place in Michigan which are beneficial to agriculture generally. Many settlers are emigrating to the State and going to work as laborers and tenants in the beet fields. These are of Hungarian, Russian, and German extraction.

Had the sugar industry built up in Michigan in the manner followed in Colorado, California, and Utah, the conditions of the State would have maintained all the factories ever built, but the process would have been slower.

The first factory was built at Bay City. Soon after others followed at Caro and Alma. These were built in districts well adapted to the beet-sugar industry. If others had not been built near these, interfering with their pioneer progress, each would undoubtedly have developed other outlying districts well adapted to beet growing. When the beet-growing area near each factory had been developed to the extent of the factory's capacity others would have been needed. The growth of factory building and the progress of the industry would have been substantial and logical and those installed would have succeeded better. New factories would have gone into developed districts where there was a local demand for them, and the main obstacle in the way of success—insufficiency of beets—would have been avoided.

In two cases factories were built in Michigan and conditions studied and developed afterwards. In other cases locations were not well chosen. For these reasons removals have occurred. In some of the same districts sugar factories may eventually be built and succeed. This was the experience at Grand Junction, Colo. There is one thing fully demonstrated in the sugar industry—before

facts and conditions in a locality are fully digested no beet-sugar factory can hope to prosper.

I have learned from reliable authority that during the past season 6 of the beet-sugar companies operating in Michigan combined into a single company under the name of the Michigan Sugar Company. Those entering into this new organization were the Alma Sugar Company, of Alma; the Bay City-Michigan Sugar Company, of Bay City, with two plants; the Saginaw Valley Sugar Company, of Carrollton; the Sebewaing Sugar Refining Company, of Sebewaing; the Peninsular Sugar Refining Company, of Caro, and the Sanilac Sugar Refining Company, of Crosswell. The capitalization of this new company is $12,500,000. Its organization represents largely the capital invested in Michigan by the American Sugar Refining Company of New York. This refining company is also the largest stockholder in 9 plants operated in Colorado, under the name of the Great Western Sugar Company. On account of the large interest of the American Sugar Refining Company in these companies in Michigan, they have been working together for two years under a sort of advisory board, composed of a representative from each, the factories, however, operating under separate managements. This new organization brings all these factories together as one concern. The objects are understood to be better results from concentration of management, distribution of the beet crop among the factories, and handling of the finished product through one sales department.

The beet area, estimated at 100,000 acres, planted in Michigan the past season was considerably larger than usual. It may be said, taking everything into consideration, that this was the most prosperous year enjoyed by the beet-sugar factories in the State. The quality of the beets was high, and the average tonnage per acre very much in excess of usual results. The campaigns of most factories in the State were very much longer, the tonnage grown for each was considerably larger, results from every standpoint were more satisfactory, and general conditions are greatly improving. The farmers producing the beets are much better prepared and more inclined to the work. The by-products are consumed to a greater extent. Michigan's prospects in the industry are more encouraging that at any time since its inception. The factories are gradually developing conditions necessary to permanent stability.

In the vicinity of Bay City are three operating sugar factories. The sugar harvest was in full blast the latter part of October. I clip from the Bay City (Mich.) Times of October 23 the following article on the status of beet production in this district:

> The sugar-factory managers of this city are wondering what in the world they are going to do with the flood of sugar beets that is pouring in upon them. Every factory is simply swamped with beets, and everything possible

is being done to discourage farmers from making any more deliveries for the time being. It is estimated that the beets already delivered equal the entire amount of last season's crop and that not over half of the season's crop has been delivered.

The contracts of two of the factories call for the payment of 25 cents a ton extra for pitted beets, while the third pays 50 cents, and it is probable that all will pay the higher amount, as they all want beets pitted and held for several weeks. The German-American Company has enough beets on hand now to run nearly a month and has stopped receiving beets. The West Bay City Company received beets to-day, but the gates will be shut to-night, and no more beets will be received by wagon until next week and no more cars will be loaded. The company has a quantity on cars in the yard now, however, that will be unloaded during the week. The Bay City Sugar Company is notifying farmers to stop deliveries to-day, but expects to receive them again in a few days.

The location of lands in Michigan so near cheap water and railroad transportation and the great markets entitles them to every improvement that will tend to perfect their utility. Beet culture has shown one great need and has pointed out the means of improvement. The excessive rains usual at the planting and harvest seasons do damage to beets, as well as to all other crops. These soils need a system of surface drainage adapted to removing more quickly and readily the excess of water. The same has been true in many parts of Ohio. Lands have been greatly improved in the latter State by a system of open ditches, successive dead furrows, shallow tile drains, etc. Such improvements are, of course, expensive. With ordinary field crops the investment is hardly justified, but with intensive agriculture, such as we have in sugar-beet growing, it is highly practical. With such a system the Michigan farmer could get onto his lands quicker after the rains during planting, cultivating, and harvesting. Cultivation at the right time would give him better control over weeds and grass and eliminate much of the expense occasioned by delay. It would improve the conditions and lower the cost of harvesting and promote the quality and quantity of the beets and other crops grown on his farm. In some of the better beet-growing districts of Michigan this improvement is taking place, particularly in the district growing beets for the St. Louis factory. The real obstacles to beet growing which I have outlined in Michigan will be considerably reduced when it shall have become more general throughout the beet-growing districts.

As an evidence of the appreciation of those best advised with reference to it and its function as a civilizing influence, I publish an extract from an article by Prof. R. A. Moore, agronomist of the Wisconsin Experiment Station, in the Sugar Industry and Beet Sugar Gazette, of Chicago, of November 20. He gives expression to his impressions of the Upper Peninsula of Michigan as follows:

SUGAR-BEET GROWING AN IMPORTANT INDUSTRY.

Instead of the Upper Peninsula of Michigan being a barren waste, only fitted for lumbering, mining, and fishing, we find there some of the finest agricultural lands in the Northwest. It will take but a few years to demonstrate that upper Michigan will vie with its sister State, Wisconsin, in the production of all farm products. The vast forests, together with the lumbering, mining, and fisheries, have, during the past half century or more, shrouded the possibilities of northern Michigan as an agricultural center. The lumbering will soon be an industry of the past, and the population will look to the soil for their support. Large tracts of land have had the heavy timber taken therefrom by the lumbermen and can be easily cleared of the remaining rubbish. No great length of time need be taken before the cut-over lands can be turned into fine farms. Within a few years some of the finest farms that can be seen anywhere have sprung up as if by magic and are now producing bountiful crops. The country is well watered and especially adapted for live stock. Tame and native grasses grow abundantly, affording very fine pasturage. Everything that can be grown on the farms finds a near-by market that can not be beaten. Lines of railroads thread the country and, with many lake ports, put the farmers in easy reach of the best markets in the world.

The farmers of the locality of which I write are especially blessed in having near them an industry that will always be a blessing and be the means of developing the country as no other industry could. The beet-sugar factory located at Menominee stands ready to convert into sugar millions of dollars' worth of beets, all of which find a ready market. Michigan and Wisconsin are leading beet-sugar-producing States, and the fact that sugar beets can be grown everywhere upon our soils has been the means of making farm property eagerly sought for.

Farmers do not realize the full benefit of having the great sugar-beet industry in their midst, and even seem skeptical in regard to its importance. I wish to state, as one having the interest of the farmers at heart, that no one move in the past decade means so much for the farmer as the establishment of beet-sugar factories near rural communities to stop the great flow of money from our country to parts unknown.

The fact that the sugar beet is a great soil renovator is often lost sight of by the farmer, who should realize the fact that cereal crops, especially barley and oats, can be grown to excellent advantage after a sugar-beet crop. When cereal crops are sown the land should be seeded down to clover, and after cutting the clover crop the following year, the second cutting should be turned under early in the season, thus putting the ground in excellent condition for beets the following year. If the second cutting of clover is retained for seed, it is well to manure the ground heavily before turning the sod, or run to pasture for one season. Rotation should be practiced, and the three-year and four-year rotations seem the best.

A farmer should not feel discouraged if he does not get a bumper crop the first year or two, as it takes some little time to learn to grow sugar beets to best advantage. He should remember, however, that there is no farm crop that will eventually bring him so great a net return as sugar beets. The sugar-beet crop in a few years will make his land double its present value. Many farmers live in such close proximity to the factory that they are able to get the pulp for the feeding of dairy animals, thus getting nearly all of the feeding and fertilizing element back from the crop to return to the soil.

Do you, as farmers, stand ready to support your factory in the most effectual ways? Do you stand ready to encourage the men who have put hundreds of thousands of dollars into a plant for the purpose largely of keeping up the industries and price of land in the country in which you live? Do you insist when going to your grocer for the purchase of sugar that you have that which is manufactured in your factory? If not, why not? Is it not the duty of everyone, in city or country, whether he be the grower of sugar beets or not, to stand valiantly by the industry that has for its purpose the development of the agricultural industry of his community?

ALMA.—The Alma Sugar Company has been operating a factory at this place for some time of 750 tons capacity. It has been one of the most successful plants in the State. This company has recently amalgamated with others under the name of the Michigan Sugar Company.

The acreage secured for beet planting during the past season was unusually large. The management in the spring published some results of beet yields in 1905, taken at random from their growers' list, as follows:

Results of beet growing around Alma, Mich., in 1905.

Name of grower.	Acreage harvested.	Value of beet crop.	
		Total.	Per acre.
W. Feichtenbiner	19.0	$1,155.71	$60.83
John Fink	3.1	161.42	52.07
C. L. Fisher	13.0	560.20	43.09
W. F. Fleming	1.5	62.78	41.85
Samuel Fletcher	6.0	505.19	84.19
W. I. Ferguson	1.0	46.42	46.42
B. F. Freed	3.0	214.32	71.44
W. H. French	1.0	54.04	54.04
Edwin F. Gee	9.0	751.67	83.52
Frank Gilkin	9.5	476.16	50.12
Glenn Wagner	2.0	91.79	45.89
W. H. Godfrey	19.0	941.85	49.54
George Godfrey	.25	11.04	44.16
Daniel Goggin	11.5	567.19	49.31
Turley Grant	3.5	169.68	48.48
James K. Griffith	2.0	107.53	53.76
J. A. Griffith	2.5	100.10	40.04
Henry Gover	5.0	410.79	82.16
John B. Hall	3.0	219.36	73.12
Otis A. Hampe	1.8	102.14	56.74
Wm. M. Harrier	.25	23.85	95.40
E. J. Hasbrook	5.6	360.95	64.45
Allen Hazelton	10.0	623.72	62.37
Eckert & Hazelton	9.0	391.74	43.52
David Helstand	5.0	405.14	81.03
L. B. Sawyer	6.4	327.24	51.13

During the early spring and growing season of 1906 the weather was more nearly ideal for this crop than any before experienced in the factory's history. So steady and bountiful was the inflow of beets on account of ideal harvesting weather that all available space for storage was taken up and the factory was compelled to call off deliveries for a while. The quality of the beets was hardly up to that of some other seasons, but the yield was far beyond expectations. Everything considered, this was the ideal year of the factory's experience.

Some blight appeared in the beet fields, thought to be due to extreme heat during the latter part of the growing season, but the damage was not serious.

At this plant all pulp is dried and shipped to available points for stock feeding. In the beet fields a new beet harvester was tried. Results indicated very good work.

BAY CITY.—The Bay City-Michigan Sugar Company has been operating a factory at this place of 600 tons capacity. It has 2 plants here, one of which has remained idle for some time. Recently arangements have been made for removing it to Waverly, Iowa.

This is one of the companies recently amalgamated under the Michigan Sugar Company. It is one of the earlier factories built in the State. Its campaigns have never been of sufficient length on account of the 5 factories installed in so small a district as that occupied by the former 3 factories at Bay City and the 2 at Saginaw, 8 or 9 miles from each other.

The acreage planted was larger than usual for this plant. The weather conditions prevalent throughout the season were generally favorable and the harvest was highly satisfactory. The average tonnage of beets was higher than ever experienced before. The quality was up to standard.

During the latter part of the harvest the plant was compelled to shut down for a short while on account of the excessive rains, which caused bad roads and made it impossible for farmers to deliver beets. There are 1,600 contracting farmers growing beets for this factory. In the Bay City district are about 5,000 farmers growing beets for this company, the West Bay City factory, the German-American Company, and the National Chicory Company, which consumes considerable beets. The three companies in their November payment to farmers dispensed $496,300. This was for only one month's delivery. In December the payment to farmers was $310,200. For the entire campaign it is estimated that in this district was paid to farmers for beets $1,000,000.

BLISSFIELD.—This factory is located in Lenawee County, in the southern part of Michigan. It is of 600 tons capacity, and is operated by the Continental Sugar Company, the same company that operates the plant at Fremont, Ohio.

This district has been growing sugar beets for some time for the plant at Fremont. It was due to this experience that the Blissfield plant was built. This is the second year of operation. The weather conditions throughout were quite favorable; the acreage planted for the factory was large; the yield was very satisfactory, and the quality of beets was all that could be desired. The plant experienced a long and successful campaign.

CARO.—The Peninsular Sugar Refining Company is operating a factory at this place of 1,200 tons daily capacity. This is one of the 6 companies recently amalgamated into the Michigan Sugar Company.

The early season was quite favorable for preparation of the seed bed and early planting. Throughout the district grub worms appeared to some extent and did some damage. The growing season was normal and the early harvest more than ordinarily favorable. Although the season throughout might be considered favorable to the growth of the beet crop, the sugar contents of the beets were not as favorable as was anticipated. The American Sugar Industry and Beet Sugar Gazette of November 11 refers to these conditions as follows:

> The fact that beets have been showing lower percentages than usual of late has caused considerable speculation on the part of the farmers, and, of course, it is equally vital to the interests of the company. Beets sent in September for analysis averaged 16.3 per cent; during October the average fell to 14.7. The season has been quite different in several respects from that of last year, and certain conditions have lowered the percentage of sugar. The conditions mentioned are the results of dry weather and early cold. The dry weather is principally responsible. This caused beets to cease growing, and instead of ripening up fully and filling with saccharine matter, large numbers of the roots stopped growing and showed a tendency to wither. As a consequence it is found that in many fields a portion of the beets favored by location will be found ripe and will run well up in sugar, while in another section of the same field the beets are undeveloped, partially green, and the sugar content is low. During the dry weather of October the beets, which had just begun to store sugar rapidly, went back in percentage, owing to the cessation of growth. In the latter part of October the percentages showed a rise, and for the last few weeks beets delivered have slowly increased in sugar. A glance over the books at the office of the Caro plant shows that the analyses are continuing favorable, and the average for November will show up much better.

CARROLLTON.—The Saginaw Valley Sugar Company is operating a factory at this place of 800 tons capacity. This was one of the 6 recently amalgamating into the Michigan Sugar Company.

The company secured a large contracted acreage. Throughout the growing season weather conditions were unusually fine.

During the campaign of 1905 the management of this factory, in order to come into closer touch with its growers, invited them in to inspect the factory and engage in general conference with each other and the management regarding mutual interests in the industry. This year the same plan was followed, and it is the aim of the company to continue this custom. Hundreds came in by wagons and buggies from the district and from a distance on the railroad by excursion cars. A programme was arranged and lunch served. The results of the meeting were highly satisfactory to all.

Beets grown for this factory were of unusually high quality. The yield was more satisfactory than for several years. A new beet harvester, manufactured locally, was tried in the beet fields this season, and its operation was fairly successful.

The pulp produced by this factory is nearly all consumed by feeders in the vicinity. The stock industry has been very much improved on account of pulp-feeding facilities.

CHARLEVOIX.—The West Michigan Sugar Company is operating a plant here this year, for the first time, of 600 tons capacity. This factory has been several years in building. From one cause or another its completion has been retarded. It has grown during this time a considerable acreage of beets, which have been disposed of at other plants. During the present season about 2,000 acres were planted. The season was not nearly so favorable in this district as in others in the State. It experienced an early drought, which lasted far into the growing season. Many of the farmers became discouraged and did not continue the cultivation of the beets, and considerable of the acreage planted was lost on this account. Where beets were well taken care of by farmers results in the end proved more favorable than anticipated. The fact that the factory actually ran a campaign and that good beets were produced where careful culture was given will do much to encourage the industry in this district.

CROSWELL.—The Sanilac Sugar Refining Company is operating a plant at this place of 600 tons capacity. During the summer a number of improvements were made on the plant. The season throughout the district was quite favorable, being similar to that in the other factory districts in the central and southern parts of the State. The contracted acreage was large enough to insure a campaign of fair length. Owing to the favorableness of the season, the average tonnage and total production were considerably larger than anticipated.

This is one of the companies recently amalgamating with others under the name of the Michigan Sugar Company.

HOLLAND.—The Holland Sugar Company has been operating a factory here of 350 tons capacity for several years. Although this is the plant having the smallest capacity in the State, it has probably achieved uniformly better results throughout various campaigns. Its contracted beet area was about 4,000 acres. The season was generally favorable, although it was a little too dry from the middle of July to the middle of September and too wet in the early harvest. The yield was not as heavy as in some other years nor the quality as good. Considerable of the pulp is consumed, but not all. Feeding, dairying, and creamery interests have been very much benefited in the locality.

During the summer the factory was overhauled and many repairs and improvements were made.

LANSING.—The Lansing Sugar Company is operating a factory here of 600 tons capacity. The acreage contracted and planted to beets was 7,000 acres. This is the largest acreage ever secured by the factory. The plant started earlier than usual.

During the preparation of the seed bed, planting, and germination it was rather wet and cold, and there was a tendency to drought and hot weather in July and August, followed by heavy rains in the early harvest. Some blight developed, being more serious in the southern part of the district and generally noticeable throughout all of it.

Considerable pulp is consumed locally. Farming interests generally contend that beet culture has a decided tendency to promote the returns and care given to other farm crops.

MARINE CITY.—The Marine Sugar Company operates a factory here of 350 tons capacity. This district is located near the eastern border of Michigan. It has been difficult for this company to procure beets enough grown in Michigan to sustain it. Many of its beets were grown in Canada. During 1905 the United States collector of customs imposed a duty on these beets, according to the vegetable rate of our tariff schedule. This was somewhat discouraging. In the early spring the company decided not to operate the plant during the campaign of 1906. Beets grown in this district were shipped to other factories in Michigan.

MENOMINEE.—The Menominee River Sugar Company is operating a factory here of 1,000 tons capacity. Menominee is located in the Upper Peninsula, where conditions are somewhat different from those in the Lower Peninsula.

This factory usually has from 40,000 to 50,000 tons of beets. About 12,000 tons of these beets are grown locally. Half of its supply is grown over in the near-by counties of Wisconsin. Many of the beets worked in this factory are grown near the lake shore and delivered by barges.

In order to sustain a long run this factory should have in the neighborhood of 100,000 tons of beets annually. Farmers are improving their methods; the average yield of beets becomes larger each year. A demand is growing for the pulp for feeding purposes, one firm sending in last campaign an order for 1,500 tons.

The farmers and factory management are better satisfied with the results of this campaign than any other since its beginning. Everything tends to encouraging a considerably larger planting next year. The average yield was about 11 tons per acre; the first year it was only 6.

MOUNT CLEMENS.—The Mount Clemens Sugar Company operates a factory of 600 tons capacity at this place. The district shared with most of Michigan in the results of a season favorable to beet growing. A large acreage was secured, and the average tonnage through-

out was equal to that of any other season in the factory's history, and the campaign was longer.

The management of this company believes in keeping in close touch with the growers. Every year at some period during the campaign excursions are held and a day is devoted to showing the beet growers the workings of the factory and to mutual consultation. This event occurred this year on December 15.

Owosso.—The Owosso Sugar Company is operating a factory here of 1,000 tons capacity. The estimated area planted to beets in 1906 was 11,300 acres. In order to take care of this large acreage it was necessary to import a number of laborers.

The campaign of the past season at this place was the longest, the yield the heaviest, and the beets of the highest quality in the factory's experience.

This company owns several thousand acres of land upon which it grew about 1,000 acres of beets. The season was not altogether favorable, being too dry, with excessive rains at harvest. From April 1 to November 1 this district received 11.25 inches of rainfall.

A new beet harvester was tried in this district with generally favorable results.

St. Louis.—The St. Louis Sugar Company has been operating a factory here of 600 tons capacity. The management of this company has adopted the idea of annually assembling its beet growers for inspecting the sugar industry and for consultation. About 6,000 farmers visited the factory on the day set apart for this purpose during the campaign this year. About 1,500 contracting farmers are engaged in producing the beets. Farm work in this district is generally conducted on the best methods. Considerable attention is given to drainage, and the methods of farming are generally of the better sort. The acreage planted to beets was larger than usual. The yield was better than in any other year of the factory's experience, but the quality of the beets was hardly up to normal.

Salzburg.—The German-American Beet Sugar Company has been operating a factory of 400 tons capacity at this place. This factory has been unique in Michigan sugar production, on account of its feature of cooperative stock. In its immediate vicinity are two other large factories. The season was a little too warm and dry.

The Salzburg factory has been more uniformly successful in securing beets and conducting long campaigns than any of the other Michigan factories. It secured a large acreage from which the yield was more than normal, and beets of high quality were secured. It is estimated by the local management that from the beets grown in the district surrounding Bay City at least 30,000,000 pounds of sugar were made this year. There were about 1,500 contracting farmers growing beets.

The factory dries its output of pulp and ships it to market for stock feeding. This drying plant was installed this year.

SEBEWAING.—The Sebewaing Sugar Refining Company operates a beet-sugar factory of 600 tons capacity at this place. The yield and quality of sugar beets in this district during the past season was quite fair.

This is one of the factories recently amalgamating under the name of the Michigan Sugar Company.

WEST BAY CITY.—The West Bay City Company has been operating a factory at this place of 600 tons capacity. Previous to this year the factory never has had a large area contracted, nor received a supply of beets sufficient to give it a campaign of fair length. This year, however, it experienced a favorable season. Its acreage was larger, the yield better, and the beets of higher quality than in any other campaign since its inception.

Working in the three factories in this Bay City district are something like 800 men. During the harvest employed in the beet fields are about 3,000 laborers. Growing beets for them are about 5,000 farmers. It is estimated that they received for the raw product about $1,000,000. The sugar contents of many of the beets ran so high this year that many farmers received $6 a ton.

MINNESOTA.

For several years beet sugar has been manufactured in the State of Minnesota. The original plant was in operation at St. Louis Park, a suburb of Minneapolis. When first established the acreage producing the beets for its first campaign was small. An unusual drought occurred during the first two years of its operation, seriously affecting the yield of all crops and affecting to some extent beet production. This was followed by excessive rains for a couple of years, interfering with crop production, but in both instances results were more favorable to beets than to other crops.

During these years the management had difficulty in securing contracts from the farmers. The beets were grown over a wide area, covering Minnesota and parts of Iowa. Each successive year the area covered grew less, while the acreage grew larger, the beets better, and the farmers more satisfied. Gradually it reduced its beet-growing district to southern Minnesota and within a radius of 50 miles of the factory. To accomplish this work required industry and careful management on the part of those operating the plant. In construction the factory itself was not ideal, for the factory building was an old harvester plant, remodeled and fitted with sugar-making machinery.

Two years ago a cyclone badly damaged the factory, delaying its campaign and causing a large outlay for repairs. A year ago it took fire and was completely destroyed. The beets grown for it were sold to the management of the factory at Menominee, Mich., and worked up there.

CHASKA.—Michigan interests owning the beet-sugar factory at East Tawas, where a large plant had been unsuccessfully operating, decided to move it to Minnesota and occupy the territory made vacant by the destruction of the factory at St. Louis Park. A location for the plant was found at Chaska, about 30 miles south of Minneapolis. The Carver County Sugar Company is operating the plant. This is its first year at this place. It has 600 tons daily capacity. The location is much better than the one at St. Louis Park. It is in the center of its beet-growing area, while St. Louis Park was not a point favorable to wagon delivery, and most of the beets had to be shipped to it by rail.

The Chaska plant started under favorable circumstances. Its pioneer work had been accomplished. Beet growers had had a long experience, and did not require experimental stages of development. The crop list in the district tributary to Chaska is very favorable to beet production. The principal farm products are small grain, potatoes, cucumbers for pickling, and sweet corn for canning. Alfalfa is also produced quite extensively. This is one of the favored crops for use in rotation with sugar beets.

Before the campaign and after the completion of the factory excursions were run bringing many business men of Minneapolis and the farmers of the vicinity to examine it and get in touch with the industry.

In addition to the beets produced for this factory in the southern part of Minnesota, about 1,200 acres were grown at Waverly, Iowa, some distance south, in order to test conditions around this Iowa town. Michigan parties holding the largest stock interests in the Chaska plant were also under agreement to build a factory at Waverly of the same size, provided conditions would warrant.

The Chaska factory is located on the Minnesota River, in Carver County. The price of beets is $5 per ton at the factory. The beet-growing area experienced a very favorable season. The yield was larger than normal in the State and of excellent quality.

MONTANA.

Considered as a beet-sugar producing State, Montana has natural conditions quite similar to those of Colorado and Idaho. Agricultural development is largely in a transitory state. Agricultural

production under irrigation is just beginning. Throughout the eastern two-thirds of the State are many fertile valleys. Cropping is dependent largely on irrigation facilities. Draining this portion of the State from west to east flow two great rivers, with their branches—the Yellowstone of the south, and the Missouri of the north, with its branch, the Milk, and its north and south fork.

Through these rivers pours an immense drainage of water collected in the mountains in the western portion of the State from rains and melting snows. Throughout these valleys in all parts of Montana extensive experiments have been conducted to test conditions for beet-sugar production. The great drawback to active operations in this industry is the lack of settlement, labor, irrigation, and facilities favorable to intensive agriculture; but these are rapidly developing.

BILLINGS.—The Billings Sugar Company operated a factory of 1,200 tons capacity at this place this season for the first time. On account of the newness of the industry, lack of labor, and general inexperience of the district, many difficulties were encountered in growing the beets. The season may be considered quite favorable. A windstorm in June damaged 400 acres. Where proper attention was given to cultivation and care of the crop, results for the first year were highly encouraging.

Outside demand for pulp the first year was not extensive. The company fed on pulp about 1,000 head of cattle and 9,000 head of sheep.

NEBRASKA.

Nebraska has been producing beet sugar for fifteen years. The factories are located in the eastern half of the State, as the organizers believed it better adapted to the beet-sugar industry. It is clearly in what is known as the corn belt. Crops are produced under rain conditions. The yield is heavy. The soil is a sandy loam, is responsive, and the seasons are fairly reliable.

The two factories are located at Grand Island, about 120 miles west of Omaha, and at Leavitt, 40 miles west of Omaha. It was difficult to interest farmers in beet production. Lack of labor and other causes have interfered with the general progress of the industry to a considerable extent.

Except in one or two years of excessive drought it may be stated that beet production has ordinarily resulted favorably. A few years ago irrigation was introduced in the western part of the State along the North Platte and Republican rivers. Around the towns of North Platte, McCook, and several other points beets were grown. Gradually the acreage was increased, until at the present time the principal

beet-growing area for the two factories at Grand Island and Leavitt is tributary to the ditches in this western section, watered by these two streams.

For these two factories over 11,000 acres of beets were grown in this western district last year. Conditions in the two sections of the State are remarkably different. In the irrigation section of the State alfalfa was introduced with sugar beets. These two crops together have proved to be the best adapted for utilizing the advantages of irrigation. Throughout both the eastern and western areas in which sugar beets are grown the conditions were more favorable this year than for some time.

The factory at Norfolk was removed and installed last year at Lamar, Colo.

After the factory at Leavitt had worked up a considerable beet-growing acreage in the western irrigated section Mr. James Scilley, an expert beet grower, was sent to oversee the work in the district tributary to North Platte, Nebr. He had acted in the capacity of assistant agriculturist at Leavitt, has had long experience, and is considered one of the best advised beet growers in the country. I insert here a short report from him bearing on conditions of beet production in the North Platte district during the past season:

We have had splendid crops this year. Farmers have all made money and are feeling good. I have had a very successful season. There were about 8,000 acres grown in this territory in 1906. Our yields reached as high as 30 tons per acre. I believe the entire acreage will average 12 tons per acre. Beets tested from 14 to 16 per cent of sugar, with a purity of 82.

Our soil varies from a sandy loam to an alkali gumbo. We have a very good system of irrigation, consisting of four ditches tapping the North Platte River at various places on the south of the river, and one ditch on the north side of the river, tapping the Birdwood. We have all the water necessary. This territory is well developed, and in my opinion it will only be a short time until a factory will be built, as the field is ripe and very inviting.

GRAND ISLAND.—The American Beet Sugar Company operates the factory here, which is of 350 tons capacity. This factory was the third to operate in the United States.

In addition to the beets grown in the vicinity of the factory and delivered to it by wagon, it receives a large acreage from the western part of the State, grown under irrigation.

Although this factory has operated a number of years, everything taken into consideration, this season is considered the best of any yet experienced by the plant. The average tonnage per acre was good and the beets were of high quality.

LEAVITT.—The Standard Beet Sugar Company operates the plant here, which is of 1,100 tons capacity. As with other factories in the State, at first its entire acreage was produced in its vicinity under

conditions of rainfall, but now the bulk of its beets are grown on the irrigated lands of the Platte and Republican rivers, in the western part of the State. While freighting such a distance necessitates considerable expense, the plant has a better assurance each year of a larger tonnage, insuring it longer campaigns.

For several years 1,200 to 1,500 acres surrounding the factory and belonging to the Standard Cattle Company were planted to beets, but finally these lands were sold. Most of the cultivated land of this vicinity are in the Platte bottom. While very rich and usually yielding very well, it is so low and level that drainage is poor. In case of excessive rainfall beets suffer quite materially. The damage on account of floods may occur in the spring or at harvest time. Throughout its existence this company has experienced many difficulties on account of this lack of drainage, washing of the land, and its saturation with water. This induced the contracting of a larger acreage in the irrigated districts farther west. While a considerable acreage of beets is now grown for it in its vicinity, at least 75 per cent of them come from this western section. Extra expense of shipping from such a distance is probably overcome in the advantages that accrue to the factory from the better quality of the beets.

A large acreage was produced for this plant in 1905. The yield was good, but on account of the unfavorableness of the latter part of the growing season the quality was very poor. While the factory had a long campaign, it is claimed that its profits were practically nothing. During the summer the plant had doubled its capacity, thereby considerably increasing its cost of construction. These improvements were made largely on borrowed money, and it was anticipated that with the large acreage and fine yields of beets the profits of the factory would pay for the improvements; but on account of the low quality of the beets and high cost of sugar production, with these heavy expenditures, it got into financial difficulties. Farmers did not receive money for a large part of their crop, the plant finally went into the hands of a receiver, and under his direction it is being managed now.

In 1906, taking everything into consideration, the factory experienced a highly favorable season and secured a more than normal yield of beets of excellent quality. In the eastern part of the State excessive rains prevailed in the early season, and during the late summer it was dry. These two conditions reduced the yield. In the irrigated sections growing beets for this factory farther west the spring was exceedingly favorable. An abundance of rain occurred during the fore part of the summer. With the exception of early snows in October, the season was more than usually favorable.

NEW YORK.

For several years New York has been producing sugar from beets. While natural conditions are quite favorable in many places in the State, the industry has had more difficulty in getting a foothold than in any other section where installed.

There are some things especially favorable to beet-sugar production in New York. Under the laws the State pays a bounty of $1 per ton to the sugar factory for all beets worked, provided the sugar factory pays the farmer $5 per ton for the beets.

Farmers and dairymen have been accustomed in this State to feeding the refuse and by-products of distilleries, starch manufactories, breweries, etc., and after the installation of the sugar factories the benefits of pulp feeding were generally appreciated from the start. The factory in this State finds a more ready sale for pulp than any other in the United States.

Notwithstanding these encouraging features, this company has experienced many difficulties in getting the farmers to grow the crop. Grown in New York are many reliable, well-established, special crops, like broom corn, peppermint, cabbage, and many garden vegetables, and these have made it difficult to persuade farmers to change to a new crop like sugar beets.

LYONS.—The Lyons Beet Sugar Refining Company has been operating a factory here of 600 tons capacity for several years. During the past season many improvements were made on the factory. The principal item worthy of mention was the installation of a pulp-drying plant, costing about $40,000.

Soil conditions as affecting beet culture in the vicinity surrounding Lyons are more peculiar than at any place I have visited throughout the beet-growing area of the country. It is generally believed that beet soil must be absolutely free from stones, pebbles, and the like; that these will interfere with the form and quality of the beets. In this vicinity during the past season fields of beets were growing where at least one-third of the visible portion of the soil consisted of pebbles and stones from the size of a bird's egg to that of a cocoanut. One could hardly understand how such land could be hoed and cultivated, yet the best beets examined grew on such soil, and it was the belief of the agriculturist that these were the best beet lands for this purpose in the beet-growing area of this factory.

From 1,000 to 1,200 Italians are laboring in the beet fields of this district, having been brought in to assist in this industry.

In some parts excessive rains, with hailstorms and floods followed by hot weather in July, did damage to the crop. Taking everything into consideration, the season was considered favorable.

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OHIO.

Sugar from beets has been manufactured in the State of Ohio for a number of years. Through many difficulties the industry has struggled to its present highly successful status. Its career in this State was something like that in Minnesota, New York, Oregon, and Washington. Its progress in winning favor with the farmers was slow but sure. The factory was located at Fremont, Ohio. In the beginning its capacity was small, it was difficult to secure sufficient beet acreage, and its campaigns were short. Feeders were slow to realize the value of its by-products. The press and public generally were nonappreciative.

Through such discouraging circumstances the plant gradually intrenched itself in the industrial affairs of the State. Each succeeding harvest gave a larger tonnage of beets. Its campaigns gradually lengthened. Its capacity was increased. More beets were produced in its immediate vicinity. Contracts for those at a distance grew less. The year of 1906 finds it literally swamped in an avalanche of beets grown at home. The agricultural and business interests of the State are aroused to the industry's importance. Its popular commendation is general.

During the present factory's career it has built up a permanent beet-growing area competent to supply several times its original capacity. Formerly a considerable acreage of its beets was grown in northwestern Ohio, near the line of Michigan. When conditions favored, it withdrew from this territory on account of the distance. The same company then built another plant at Blissfield, Mich. During the past season more beets were grown for the Fremont factory in the farming district tributary to Defiance than it could originally secure in the whole State. Enough beets are now produced there to sustain a sugar factory. The original factory can secure enough beets in its own vicinity to run a long campaign. The indications are that a factory will be needed at Defiance to take care of the beets grown there.

The State possesses many advantages for the beet-sugar industry. Its farms are usually small, productive, and adapted to intensive agriculture. The demand for sugar in the State is very large; markets are near; fuel is of good quality and comparatively cheap. Considerable stock is grown on the farms. Farmers as a rule are of the better class.

FREMONT.—The Continental Sugar Company has been operating this factory, which has a capacity of 400 tons. It is the pioneer in the State, and beet production has overleaped its facilities for manufacturing sugar.

The season, everything considered, was the most favorable yet experienced in the history of the factory. A large acreage of beets was secured. The tonnage produced for it was by far the largest in its career.

At Defiance a large acreage was planted to beets for this factory during the past season. Nearly all the farms were originally in timber, and the lands are named after the prominent species of timber which grew on them, as elm land, oak land, etc. These lands became too wet as the result of excessive rains in the spring and occasionally during the growing season or during harvest. Without some method of removing the surplus moisture lands are of little use for cropping. On this account many of these lands were for years of small value. Finally a system of drainage was introduced. This consisted of open drains bordering the low places in the small fields or tile drains put in at a depth of 1½ to 2 feet. To aid this surface drainage, the lands are plowed with a system of dead furrows not far apart, extending across the field in the right direction for drainage. While inspecting beet fields during the past season it became my privilege to observe the need for such a system. A heavy rain had just fallen, and I saw in several places 2 or 3 acres of beets standing in surface water. The weather was hot, and in two or three days the beets were scalded and became soft and rotten.

The management of this factory has a very unique and effective system of governing its experts in the beet fields. For the factories at Fremont and Blissfield and for other districts, like that around Defiance, having a large acreage of beets, it maintains a corps of experts or agriculturists. Altogether about 36 of these are employed. At some time in the growing season, after the beets are laid by, the management assembles this corps of experts for four or five days at some convenient point along the lake. This gives them a rest and an outing in the season between cultivation and harvesting. Twice a day they are assembled together for mutual discussion of matters pertaining to their work in the field. After advising with these men, who are its active agents for dealing with the farmers, the management gives instruction on the work of the coming harvest. The management gains from the experience of the field men and comes into closer touch with the conditions that have to be met. The men gain from learning one another's experiences. I attended this conference at Put in Bay, Lake Erie, during the past summer. I was very much impressed with the evident results of such a plan, and can heartily commend it to the consideration of other factory managements in this country.

This factory experienced the car-shortage difficulty prevalent throughout the country. On account of the large tonnage produced

this proved very serious in some localities. Many of the beets had to be siloed, which resulted in considerable loss.

OREGON.

Sugar has been manufactured from beets in Oregon for a number of years, but the progress has not been as rapid and pronounced as in some other States. While the acreage planted and the tonnage produced have been increasing each year, it may be said that general reception of the industry by the public has not been enthusiastic. This is largely due to conditions other than agriculture. There can be no doubt about the adaptability of many parts of Oregon to the beet-sugar industry, especially the Grand Ronde Valley, where the factory is located; but the hard work incident to growing beets has not appealed to the farmer in the locality where it was established. After the first year's experience considerable discouragement was felt by many farmers in its vicinity. It became necessary for the management to make contracts at various outside places at some distance from the factory. This made progress slow; but more permanent beet growers have gradually been added to the list. It may be said that people are becoming more generally favorable, and appreciate to a greater extent the benefits of the industry. A larger acreage is being planted near the factory than formerly.

LAGRANDE.—The Amalgamated Sugar Company operates this plant, which has 400 tons capacity. For planting the seed, bunching, and thinning, the weather conditions were very favorable; but there was some dry weather during the summer and storms during the harvest. In July the manager of the factory estimated that 3,600 acres were planted, and 3,500 of these had a good stand.

More laborers were brought in this year to work in the beet fields. Among these were several hundred Japanese and a large number of Umatilla Indians. This particular section produces fruit extensively. Fruit culture and harvesting demand considerable labor. In competing for labor the two interests conflict to some extent.

One improvement which materially benefited this district was the building of a spur road, equipped with facilities for loading beets. This extended the beet-growing area.

The factory was shut down about two months during the campaign on account of stormy and cold weather which prevented harvesting.

Generally considered, results of the past season were more favorable than usual.

UTAH.

The beet-sugar industry in Utah is not so extensive as in Colorado, Michigan, or California, but its progress has been more remarkable. It has developed with a steady growth.

It does not appear that natural conditions of soil and climate are as favorable to large yields or to beets of high quality as in Colorado. In fact, the history of the first factory shows that for several years the tonnage was not large and the quality was only fair. The success of the industry in the State may be said to be due largely to the industry, habits, and staying quality of the farmers. The farms in Utah are small, and the necessity of making the most out of them is a pressing consideration at all times. While irrigation was practically in its infancy at other places Utah had thoroughly established systems of watering the soil. The people of the State have builded and progressed on the basis of intensive production. The requirements of the sugar industry conformed to their habits and aspirations. They had the patience and were willing to acquire the skill. They act more in unison to a common purpose than any other community of farmers it has been my experience to observe. With little public parade, through hardships and many difficulties, the first plant met its problems, solved them, and increased its manufacturing facilities to keep up with beet production. Finally it built another factory, and it is now actively considering the installation of others. Taking advantage of the progressive tendency to beet production, another company was organized in the State. In response to the rapid development of its beet-growing area, it built a second factory, and, finally, a third. Beet-sugar production in Utah is conducted entirely under the management of these two companies.

Some things of interest have been developed in the State of Utah which redound to the benefit of the whole industry. One year blight affected the beets, materially reducing the tonnage. Many thought the affliction would be carried over into the beet fields the next year. This did not occur. In 1905 the beet fields were seriously affected with the pest known locally as the "white fly." This proved very serious in all the beet fields of Utah and Idaho. From this cause it is estimated that the Utah Sugar Company alone lost 75,000 tons of beets. Many farmers refused to contract for beets for 1906, fearing a transmission of this pest to the crops, but this did not occur. There was very little evidence of its ravages during the past season. The season itself proved to be one of the best ever experienced in the history of beet-sugar production in Utah. A shortage of cars was the only real obstacle encountered this year. This is one that seems to have prevailed throughout the beet-sugar districts in all parts of the United States. The tonnage was heavy and the beets were of a high quality.

As an evidence of the importance of the industry in the State of Utah, I clip from the Deseret News (Salt Lake City) of December 15 a compilation of the resources and results of beet-sugar produc-

tion in that State for 1906. On this subject this secular paper is perhaps better informed than any other paper in the United States:

Results of the beet-sugar industry in Utah for 1906.

Total acreage	acres	27,100
Total tonnage	tons	365,000
Average yield per acre	do	13.47
Total capital invested		$9,100,100
Total money paid farmers for beets		$1,675,000
Total money paid by factory for labor		$270,000
Output of sugar (see table below)	pounds	78,000,000
Value of refined sugar at 4½ cents per pound		$3,510,000

Results of factory operations in Utah in 1906.

Name and location.	Estimated production of sugar.	Daily capacity for working beets.	Estimated length of campaign.	Number of factory employees.	Number of farmers growing beets.
	Pounds.	*Tons.*	*Days.*		
Amalgamated Sugar Co., Ogden [a]	12,000,000	400	120	200	1,100
Amalgamated Sugar Co., Logan	10,000,000	600	110	200	950
Lewiston Sugar Co., Lewiston	9,000,000	600	110	200	900
The Utah Sugar Co., Lehi	27,000,000	1,200	125	306	1,800
The Utah Sugar Co., Garland	20,000,000	600	120	160	600
Total	78,000,000			1,066	5,250

[a] Does not include the output of the factory at La Grande, Oreg., which will amount to about 2,250,000 pounds.

GARLAND.—The Utah Sugar Company operates a plant here of 1,200 tons capacity. For some time beets were grown to a greater or less extent for the Lehi factory. The district is watered through canals supplied from Bear River. The beets grown are usually of high quality. The soil is productive. The farming element of the district is not well organized, and the district itself is rather a new one. The company never has received sufficient beets to give a plant of its large capacity a long campaign. The past season resulted more favorably than any preceding season.

While the acreage secured for growing beets for this plant was not large, the yield was very heavy, several farmers securing as high as 30 to 35 tons per acre. Under these ideal conditions it is estimated that the plant had about 83,000 tons of beets, that the average yield was 16 tons per acre, and that the sugar contents averaged 16 or 17 per cent.

Developing this district to this high productive point has been quite difficult. The results may be attributed to some extent to the favorable season. A great deal is due to the efficiency of the farmers, acquired after a few years' experience. The soil for beet purposes is of excellent quality. The district has plenty of water, and the farmers are coming to understand more thoroughly their part of the work.

A feature of general interest is the Utah Sugar Company's production of beet seed. It has been engaged in this for several years. Most of the work is carried on in the Garland district. The company also cooperates in experimentation with the seed experts in the Bureau of Plant Industry of the United States Department of Agriculture.

Most of the refuse sirup of this factory is shipped to feeders at Omaha, who mix it with chopped alfalfa and other material for cattle and sheep feeding. It disposes of most of its pulp for 50 cents per ton.

I clip from the Deseret News (Salt Lake City) of December 15 a compilation of results from a few of the leading beet growers for the Garland factory, as follows:

Results of beet growing around Garland, Utah, in 1906.

Name and location of grower.	Area harvested.	Yield per acre.
	Acres.	*Tons.*
H. L. Steed, Corinne	55	18.3
D. W. Hunsaker, Honeyville	23	18.21
Geo. C. Peck, Fielding	24	19.41
J. T. Bigler, Riverside	22	18.64
O. Jensen, Honeyville	38	18.94
Merrill Salt Co., Brigham	25	18.87
James Nelson, jr., Thatcher	30	21.94
M. Hall, jr., Garland	22	18.34
R. C. Richards, Riverside	23½	18.82
J. P. Holmgren, Bear River City	67	17.75
J. M. Hawes, Elwood	23	21.91
Beet Growing Association, Garland	104	18.23

LEHI.—The Utah Sugar Company is operating a plant here of 1,200 tons capacity. This plant is unique in that it is a combination of beet-sugar plants. The main plant has a capacity for turning out the sugar from the juice of about 1,200 tons of beets per day. This factory proper can only slice 350 tons. It has three stations, or plants, each having a capacity for slicing and extracting the juice from about the same number of tons. This juice is limed and pumped to the main plant through pipe lines for distances ranging from 12 to 25 miles. The main plant evaporates the juice from all of them. This arrangement was necessitated by lack of railroad facilities to meet the requirements of these outlying districts. They have been in operation for several years and are considered so practical and valuable that when the company managing this plant built another at Sugar, Idaho, a slicing station was installed there.

It may be said the past season was the most favorable of any yet experienced by the factory. It had a large acreage, the tonnage of beets was heavy, the quality excellent.

LEWISTON.—The Amalgamated Sugar Company is operating a factory here of 600 tons capacity. The past season was its second cam-

paign. Farms growing beets for this plant are watered by irrigation from Bear River. In this new district agricultural development has not proceeded sufficiently to keep a sugar factory running at its full capacity for a full campaign. Experience has demonstrated, however, that the soil is well adapted, the district is sufficiently watered, and that beets of high quality can be produced.

Before the establishment of this plant a large acreage had been grown in this vicinity for the plant at Logan. In the vicinity of the plant 1,750 acres of beets were grown last year. It had 1,310 acres in adjoining settlements. The total tonnage harvested was 31,000 tons.

Everything considered, the season was unusually favorable. The yield was large and the quality of the beets excellent. In the district producing beets for the factory the favorable results of this year are tending to a very much increased interest in beet production. A considerably larger acreage is anticipated for next year. The results of the past season have undoubtedly placed beet-sugar production higher in the estimation of the public.

LOGAN.—The Amalgamated Sugar Company has been operating a factory here of 600 tons capacity. As at Lehi and Ogden, the Logan plant required several years to place its working conditions on a solid basis. Last year the season at this place, as at the others, was the best experienced in the factory's history. About 4,500 acres of beets were planted. This was more than usual. The tonnage furnished this factory was large, the yield was heavy, and the beets were of excellent quality.

The operation of the plant at this place has not only served to build up for itself in its own locality permanent working conditions, but it has been the principal factor in establishing the same at Lewiston, where a plant was built a couple of years ago.

OGDEN.—The Amalgamated Sugar Company is operating a plant at this place of 400 tons capacity. It has been very much improved with new equipment and the addition of new processes.

Previous to building this plant the district around Ogden was furnishing raw material for several canning factories. At first there was apparent conflict between these several industries. The ultimate effect was beneficial to all. It gave a stimulus to intensive production. In growing tomatoes and other things for canning, the farmers found it desirable to rotate their crops and grow sugar beets for the factory, and on the other hand beet growers resorted to the other crops. Together they have developed the farming district thoroughly in sustaining these manufacturing industries.

In common with the other factories of the State, it experienced the most favorable season in its history. A shortage of cars was the only difficulty occurring worth mentioning. The yield was larger,

and the quality of the beets was excellent. To both the factory management and farmers results this year were highly satisfactory. A fair acreage was planted. The stand on most of this was excellent. Under the favorable conditions prevalent in the district the yield was large and the campaign of the factory longer than for several years.

All pulp produced by this factory is consumed by local feeders.

WASHINGTON.

Sugar has been made from beets in the State of Washington for a number of years. Up to date most of the beets grown from which sugar is manufactured have come from districts producing crops under rain conditions. The progress of this factory has been slow, but from year to year the situation has grown more favorable. Beets grown in the State are usually of very high quality. On account of the tendency to drought, the tonnage has not been as high as in most sections of the country. For this reason the factory pays a higher price for its raw material than most other factories in the United States.

This State has been investigated very extensively in all its parts with a view to extending the beet-sugar industry. For cultivated crops some sections are dependent entirely upon irrigation. Many irrigation systems are being established, and in some cases the establishment of a beet-sugar factory appears to be the ultimate object.

WAVERLY.—The Washington State Sugar Company operates the sugar factory here. Its capacity is 500 tons of beets daily. On account of insufficiency of beets it has never been able to run a long campaign at its full capacity. The management has been very active in promoting the improvement of conditions. By adding additional railroad facilities, thus bringing new cultivated lands into use and reaching others recently put under irrigation, it is believed that the plant in future will be able to procure a competent supply of beets.

In the vicinity of this plant is operated the largest beet-seed-producing enterprise anywhere in the United States. In connection with this work the Department of Agriculture, through the Bureau of Plant Industry, has been cooperating in the production of high-grade beet seed, and has also been experimenting on the production of single-germ seed. Beet seed produced in this vicinity is of high quality and germinating power. The industry has not developed as yet sufficiently to affect the supply required in the country. Indications point to favorable results in the future.

During the early part of the growing season a period of drought covering a month and a half affected the crop to a considerable extent. The latter part was better. The yield was not heavy, but the quality was excellent.

WISCONSIN.

Beets have been grown and manufactured into sugar in this State for several years. The industry has had a peculiar history. Attempts were made in this State many years ago to manufacture sugar from beets, the result being a signal failure. The absolute lack of favorable conditions, aside from the soil conditions, may be assigned as the cause. Later a plant was built at Menomonee Falls, a large acreage of beets was grown for it, and a second failure was recorded. This was due entirely to the poor construction and equipment of the plant. Farmers growing the beets and capitalists who put their money into it were heavy losers. Experiments continued under the director of the State experiment station at Madison. From an experimental standpoint every indication was favorable. Wisconsin has developed extensive agricultural and commercial interests. It has the markets and the facilities to reach them; large dairy and live-stock interests, and large areas of cut-over timber lands, some of which have been reclaimed. These stump lands are cheap and available for further extending the sugar industry. These lands are fertile and cheap. They have all the natural conditions most favorable to root corps. Potatoes and turnips, ruta-bagas, mangel-wurzels, sugar beets, and everything of that description yield abundantly and are of high quality. The presence of dairies and the availability of these cheap lands all appeal to the establishment of some such industry as will encourage intensive features of agriculture.

A few years after the failure at Menomonee Falls a new company organized, bought the old plant, discarded its old machinery, and installed a new up-to-date equipment. A fair acreage was secured for the first campaign. This proved most satisfactory. The management has from year to year been increasing its acreage, improving its conditions for producing the beets, and working up interest among the farmers. Finally it built up a large beet-growing area. As a result of the favorable conditions developed by this company in other districts it has been necessary to install three other large sugar factories—at Janesville, Chippewa Falls, and Madison.

One of the principal things of interest to the industry occurring in this State during the past year was the effort made before the railroad rate commission by the sugar plants to secure a reduction of freight rates on raw material. An account of this matter is given in the following article, clipped from the Madison (Wis.) Journal of December 3, 1906:

A sweeping decision was rendered by the railroad rate commission this morning against the several railroads of the State declaring that the present rates on sugar beets and beet pulp are unreasonable, that the rules are unjust, and ordering a 20 per cent reduction in the rate of transportation.

The complaints of excessive rates were made by the Wisconsin Sugar Company, of Menomonee Falls; Rock County Sugar Company, of Janesville; and the Chippewa Sugar Company, of Chippewa Falls, against the Chicago and Northwestern; Chicago, Milwaukee and St. Paul; Minneapolis and Omaha; Wisconsin Central; and Illinois Central roads.

Several hearings have been held on the matter of rates. The minimum rate for the shipment of sugar beets for 25 miles or less was formerly 50 cents. The commission to-day reduced the rate to 40 cents per ton and placed the minimum on a carload of sugar beets at 30,000 pounds. The commission orders that the joint rate in any case shall not be more than 10 cents per ton greater than the regular rates fixed by the commission. The following rates were ordered:

	Per ton.		Per ton.
25 miles and under	$0.40	151 to 175 miles, inclusive	$1.20
26 to 50 miles, inclusive	.50	176 to 200 miles, inclusive	1.30
51 to 75 miles, inclusive	.65	201 to 225 miles, inclusive	1.40
76 to 100 miles, inclusive	.80	226 to 250 miles, inclusive	1.50
101 to 125 miles, inclusive	.95	251 to 276 miles, inclusive	1.60
126 to 160 miles, inclusive	1.10	276 to 300 miles, inclusive	1.70

The commission decided that the rules complained of regarding the minimum load required on every carload of beet product were unreasonable and unjust.

About half the beets worked by the factory at Menominee, Mich., are grown in Wisconsin.

J. D. Beck, labor commissioner, Madison, Wis., December 12, says:

The total output of the Menominee (Mich.) factory this year is estimated at 6,000 tons of sugar, of which 3,000 should be credited to Wisconsin beets. The output of the factory located at Madison will be about 2,800 tons of sugar; of the Menominee Falls factory 6,700; of the Janesville factory, 4,800, and of the Chippewa Falls factory, 4,500, making a total output for Wisconsin in 1906 of 21,000 tons of sugar.

CHIPPEWA FALLS.—The Chippewa Sugar Company has been operating a factory of 600 tons capacity here for two seasons. It is under the same management as that at Menominee Falls. A larger acreage was procured this year. The season was very favorable. For a new district results were highly satisfactory. In addition to the supply grown in this district, 2,000 tons of beets were purchased from the management of the Janesville factory.

JANESVILLE.—The Rock County Sugar Company has been operating a factory here of 600 tons capacity. In the district tributary to it are grown about 10,000 acres of tobacco. At the outset tobacco interests were inclined to discourage beet production, but it was found that there was plenty of room for both; in fact, that each was a natural complement of the other. Both can be grown more profitably in rotation with each other. It gives two valuable intensive crops in a cycle of rotation.

Everything considered, the season was better than normal. The tonnage produced in the district for this factory was highly satis-

factory. The quality of the beets was not as high as in other years. Results are tending much to stimulate the industry in this vicinity. Prospects indicate that the plants in Wisconsin will secure all the acreage desired.

MADISON.—The United States Sugar Company is operating a plant at this place of 600 tons capacity. The beet-growing area of this factory is also in that of a large tobacco-growing district. In culture and expense the tobacco crop more nearly approaches beets. Many of the old tobacco growers are taking to beet culture readily. As demonstrated in other districts in the State, beet growers will eventually take to the cultivation of tobacco as a suitable crop for rotation with beets. In this way the two crops will be mutually helpful.

A large acreage was secured for this factory. General results throughout the district were highly satisfactory. The season was up to normal. The yield of beets was good and the quality fair.

MENOMONEE FALLS.—The Wisconsin Sugar Company is operating this factory of 500 tons capacity. It was the first successful plant established in the State. From its operations the installation of the others has been encouraged. The management of this plant in securing beets and encouraging the farmers to develop favorable conditions throughout the State may be considered a model in the work of the beet-sugar industry of the country. A large tonnage of beets was produced for it in its own immediate vicinity last year. It also received a considerable tonnage from other plants in the State, 5,000 tons having been purchased from the management of the Janesville factory.

Conditions of season and production were normal. On account of superior methods and adaptability to the work the farmers are accustomed to securing good yields and beets of excellent quality, and they were not disappointed the past season. The weather for planting and growing the crop was favorable up to the middle of July. From that time it was too dry to September 10. Rains commenced about the time the beets were ripening, reducing the sugar contents of the beets for a time.

All of the pulp produced by this factory is consumed very readily by the dairying and feeding interests in its immediate vicinity.

A new beet topper and puller was put into use in the district, and its work proved very satisfactory.

STATISTICS OF THE SUGAR INDUSTRY.

Under this heading I include (1) statistical data which I have gathered relating to the beet-sugar industry in the United States, and (2) statistics of the world's production of sugar (both cane and beet), as compiled and published by Willett and Gray.

STATISTICS OF THE BEET-SUGAR INDUSTRY IN THE UNITED STATES.

For the past year I offer (1) a table showing the acreage planted to beets in 1906, and (2) a table showing factory and farm results for 1906, with the totals and averages for the five preceding years appended for purposes of comparison.

ACREAGE PLANTED TO BEETS IN 1906.

The following table shows the acreage planted to sugar beets in 1906, by States:

Acreage planted to beets in 1906.

State.	Acres.	State.	Acres.
California	65,513	Wisconsin	16,650
Colorado	114,190	Nine other States having one factory each	39,928
Idaho	20,780		
Michigan	99,665	Total	396,615
Nebraska	15,201		
Utah	24,688		

Owing to unfavorable weather, mistakes of growers, neglect, and other causes, a part of the acreage planted is abandoned every year; but a comparison of the foregoing figures with the figures for acreage harvested, which appear in the general table, indicates that the acreage abandoned in 1906 was comparatively small—only a little over 5 per cent; in other words, the growers harvested about 95 acres out of every 100 planted. In Utah and Idaho almost all the acreage planted was harvested, while in Colorado and several of the less important producing States less than 3 per cent was abandoned.

GENERAL FACTORY AND FARM RESULTS.

The following table contains statistics of factory and farm results for 1906, with the averages and totals for the five years 1901–1905 appended in order to show the progress made:

General factory and farm results.

BY STATES, FOR 1906.

State and year.	Factories in operation.	Area harvested.	Average yield of beets per acre.	Beets worked.	Sugar manufactured.		Estimated average extraction of sugar.	Average sugar in beets.	Average purity coefficient of beets.	Average length of campaign.
					Pounds.	Tons.[a]				
		Acres.	*Tons.*[a]	*Tons.*[a]			*Per ct.*	*Per ct.*		*Days.*
California	8	60,141	11.17	671,571	185,480,000	92,740	13.81	16.7	82.7	115
Colorado	15	110,943	13.41	1,487,383	334,386,000	167,193	11.24	14.7	80.3	132
Idaho	4	19,950	11.48	229,023	56,798,000	28,399	12.40	16.9	86.8	95
Michigan	16	93,984	8.57	805,309	177,214,000	88,607	11.00	14.5	83.2	85
Nebraska	2	13,650	9.77	133,387	30,754,000	15,377	11.53	13.7	80.6	136
Utah	5	24,108	15.88	382,769	80,848,000	40,424	10.56	14.5	81.8	123
Wisconsin	4	15,560	10.19	158,600	35,220,000	17,610	11.10	13.6	83.0	88
States having but a single factory:[b] Arizona, Illinois, Kansas, Minnesota, Montana, New York, Ohio, Oregon, Washington.	9	37,738	9.75	368,070	66,524,000	33,262	9.04	14.4	81.2	86
Total and average[c]	63	376,074	11.26	4,236,112	967,224,000	483,612	11.42	14.9	82.2	105

TOTALS AND AVERAGES,[c] BY YEARS, FOR 1901–1905.[d]

		Acres.	*Tons.*[a]	*Tons.*[a]			*Per ct.*	*Per ct.*	*Per ct.*	*Days.*
1905	52	307,364	8.67	2,665,918	625,841,228	312,921	11.74	15.3	83.0	77
1904	48	197,784	10.47	2,071,539	484,226,430	242,113	11.69	15.3	83.1	78
1903	49	242,576	8.56	2,076,494	481,209,087	240,604	11.59	[e] 15.1	(*f*)	75
1902	41	[g] 216,400	8.76	1,895,812	436,811,685	218,406	11.52	[h] 14.6	[i] 83.3	94
1901	86	175,083	9.63	1,685,689	369,211,733	184,606	10.95	14.8	82.2	88
Averages 1901–1905	....	227,841	9.13	2,079,089	479,460,033	239,730	11.53	15.0	82.3	82

[a] Short tons—2,000 pounds.

[b] Grouped together to avoid giving publicity to the data of individual factories.

[c] The average yield of beets per acre is found by dividing the total beets worked by the total acreage; the average extraction, by dividing the total sugar produced by the total beets worked; the averages for sugar contents, purity coefficients, and length of campaigns, by adding the figures for each factory and dividing by the number of factories in operation.

[d] Compiled from reports on The Progress of the Beet-Sugar Industry in the United States for the years 1901 to 1905.

[e] This percentage represents data from only 14 out of 49 factories operating in 1903, no reports having been received from the others. The percentages of extraction reported by the other factories, however, indicate that this figure is probably too low rather than too high.

[f] Coefficients of purity were, unfortunately, not included in report for 1903.

[g] In the report for 1902 (p. 114) the statistics of "factory and farm results" contain data on acreage harvested for only 27 out of 41 factories in operation, the total for these being 166,127 acres. The total acreage for the year given here—216,400 acres—is the result of a carefully made estimate based on the total tonnage reported for the 14 factories not reporting acreage and the weighted average yield per acre of the 27 which reported acreage. The belief that this estimate is conservative is confirmed by comparison with the figure given by Willett and Gray for acreage in 1902.

[h] Represents 19 out of 41 factories in operation in 1902.

[i] Represents only 15 out of 41 factories in operation in 1902.

The data are given by individual States for all those States in which more than one factory is located; but the data for all the States (9 in number) having only one factory each are grouped together. This plan is adopted to avoid giving publicity to data concerning the operations of individual factories.

The striking feature of the results for 1906 is the immense gain made, the enormous stride taken by the beet-sugar industry. In nearly all respects the year has been a record breaker. When the figures are compared with the general averages for the preceding five years—1901–1905—it is seen that the acreage harvested in 1906 shows an increase of 65 per cent, while the tonnage of beets worked and the yield of sugar are more than double the five-year average.

NUMBER OF FACTORIES.

The first figure column shows the number of factories in operation, the largest number being in Michigan and the next in Colorado. The total number, 63, exceeds the number for 1905 by 11, and 3 new States were added to the list of sugar producers. The increase in number of factories over 1905 was 21 per cent.

ACREAGE HARVESTED.

The second column in the table shows the acreage of beets harvested. The total, 376,000 acres, exceeds that of 1905 by nearly 69,000 acres, or more than 22 per cent; is nearly double that of 1904, more than double that of 1901, and exceeds the five-year average by 65 per cent, as already stated.

Nearly all the States show an increase in acreage over that of 1905, the largest increases being 25,000 acres in Colorado, 16,000 in Michigan, and more than 8,000 in California.

YIELD OF BEETS PER ACRE.

The third column shows the average yield of sugar beets per acre. The average for the whole country was 11.26 tons per acre, the highest on record, exceeding that of 1905 by 2.6 tons and the five-year average by 2.13 tons, or 23⅓ per cent. This fine showing was due mainly to the favorable character of the growing season, but doubtless better cultural methods were a factor.

The highest yield per acre shown in the table is that of Utah, 15.88 tons, and the next highest that of Colorado, 13.41 tons. The greatest gain over the tonnage of 1905 is also shown in Utah, an increase of nearly 8 tons. Colorado shows an increase of more than 3 tons per acre, and Idaho and Wisconsin follow with gains of between 2 and 3 tons. The figures indicate that the yields were good

throughout the entire country, the lowest yield shown in the table—8.57 tons per acre in Michigan—being higher than the general average for the whole country in 1903.

TOTAL YIELDS OF BEETS.

The fourth column shows the tonnage of beets actually worked by the factories, and here again we see a great and gratifying increase, the gain over 1905 being more than 58 per cent, and over the five-year average (1901–1905) nearly 104 per cent.

The greatest increase in total tonnage over that of 1905 is that of Colorado, a gain of 612,000 tons, or 70 per cent. Utah shows an increase of 160,000 tons, or 72 per cent; Idaho a gain of 58 per cent, and Michigan a gain of nearly 52 per cent.

PRODUCTION OF BEET SUGAR.

The fifth column shows the production of sugar in pounds, and the sixth column the same in tons of 2,000 pounds. Compared with the production for 1905, these figures show an increase of nearly 55 per cent, and compared with the five-year average, an increase of nearly 102 per cent.

Idaho shows a gain in production of sugar over 1905 of more than 83 per cent, Colorado a gain of over 82 per cent, and Utah a gain of nearly 67 per cent.

CHARACTER OF THE BEETS.

The seventh and eighth columns show the percentage of sugar in the beets and the coefficient of purity. These figures are slightly lower than the figures for the best of the preceding years, but they are practically identical with the averages for the five years, 1901–1905. Lower sugar content and purity are usually expected to accompany heavy yields; consequently, in view of the large yields of beets in 1906, the character of the beets must be considered excellent. The beets grown in Idaho and Nebraska showed a considerable increase over those of 1905 in both sugar content and purity.

LENGTH OF CAMPAIGNS.

The ninth figure column in the general table shows the number of days the factories were in operation during the past season. The average length of campaigns for all the factories was 105 days, which was longer by 11 days than the highest previous record. It exceeded the average for 1905 by more than 36 per cent, and it was greater by 28 per cent than the average for the preceding five years.

In fact, the average for 1906 was 5 days longer than the assumed normal average of 100 days.

The large increase in the working periods of the factories was, of course, due almost entirely to the great beet crop they had to work upon. Campaigns below the normal had been the rule prior to last year, owing mainly to insufficient acreage.

SUGAR EXTRACTION.

The last column shows the percentage of refined sugar extracted, the basis being the weight of the beets worked. The difference between these percentages and the percentages of sugar in the beets represents the small amount of sugar left in the pulp and the much larger amount remaining in the molasses. This loss ranges from 2¼ to 4½ per cent of the weight of the beets with different factories, the average in different years varying from 3½ to nearly 4 per cent.

The percentage of extraction for 1906 was a little lower than the average for the five-year period. This decrease does not, however, indicate a lower efficiency in the factories, but is due to the heavy tonnage of beets.

COMPARISON BY SECTIONS.

If we compare the development of the beet-sugar industry in the far West, where the beets are grown mainly by irrigation, with that in the middle and eastern sections, where beets are grown by rainfall alone, it is apparent that its development in the West under irrigation has been far more rapid and extensive.

In 1906 the two States of California and Colorado alone, with 36 per cent of the factories, had over 45 per cent of the beet acreage, grew 51 per cent of the total tonnage, and produced over 53 per cent of the total beet sugar in the United States.

If we include with these two States the neighboring coast and mountain States of Oregon, Washington, Idaho, Utah, Montana, and Arizona—eight in all, or just one-half the beet-sugar producing States—we find that they have 57 per cent of all the factories, 61 per cent of the acreage, about 68 per cent of the beets, and nearly 71 per cent of the beet-sugar product of the United States.

If we include with these mountain and coast States Nebraska and Kansas, where irrigation is depended on to supplement rainfall in growing most of the beets, we have 10 States with 62 per cent of the factories, 66½ per cent of the acreage, 73 per cent of the total beets grown, and nearly 75 per cent of the beet sugar made in the United States.

A further examination of the figures given in the table of general results shows that the principal beet-growing States of the West have

the highest yields of beets per acre, beets with highest sugar contents and coefficients of purity, the longest factory campaigns, and the highest percentages of extraction in the factories.

It appears, therefore, that, on the whole, the Western States, where irrigation is practiced, are better adapted to the beet-sugar industry than the States farther east, where dependence for moisture is on rainfall only. The advantages of the West are, however, offset to some extent by the considerably lower cost of growing beets and by better markets and consequently higher prices for the product of the factories in the Middle and Eastern States.

VALUE OF PRODUCTS FOR 1906.

Some idea of the magnitude of the beet-sugar industry in the United States can be given by estimating the value of the beets sold by the growers to the factories and of the refined sugar placed on the market by the factories.

If we assume that the average price paid for beets in 1906 was $5 per ton, the total value of the 4,236,112 tons of beets harvested is $21,180,560. If we estimate the value of the sugar at 4½ cents per pound, the 967,224,000 pounds of sugar manufactured was worth $43,525,080. Probably the assumed prices both for beets and for sugar may be a trifle below those actually received, but these figures are sufficiently accurate to indicate the magnitude of the industry.

THE WORLD'S PRODUCTION OF SUGAR.

The following table shows the production of sugar in all the sugar-producing regions of the world for the years 1902–1906 inclusive. Two noteworthy features are (1) that the total production for 1906 is the highest on record, and (2) that the total production of beet sugar and of cane sugar are almost exactly equal.

Sugar production of the world.

[Prepared in the Division of Foreign Markets, Bureau of Statistics.]

Country.	1902–3.	1903–4.	1904–5.	1905–6.	1906–7.
CANE SUGAR.					
United States:	*Tons.*[a]	*Tons.*[a]	*Tons.*[a]	*Tons.*[a]	*Tons.*[a]
Louisiana and Texas	329,226	234,800	350,000	342,000	243,000
Hawaii	391,062	328,108	380,576	383,225	390,000
Porto Rico	85,000	130,000	145,000	213,000	255,000
Total United States[b]	805,288	692,908	875,576	938,225	888,000
Cuba	998,878	1,040,228	1,163,258	1,178,749	1,250,000
Other West Indies	260,163	268,306	244,837	300,618	291,000
Mexico	112,679	107,547	107,038	107,529	115,000
Central America	21,500	21,450	19,768	18,516	19,000
South America	579,022	601,134	590,382	700,001	654,000
Total America	2,777,530	2,731,568	3,000,859	3,243,638	3,217,000
Asia	2,839,596	2,641,547	3,284,775	2,861,819	3,385,446
Africa	277,478	321,706	232,101	283,364	295,000
Oceania	133,126	163,328	216,213	230,000	249,000
Europe	28,000	28,000	18,592	14,512	15,000
Total cane-sugar production	6,055,725	6,086,149	6,752,540	6,633,333	7,161,446
BEET SUGAR.					
United States	195,463	208,135	209,722	283,717	[c]433,010
Canada	6,696	6,710	8,084	11,419	11,367
Total America	202,159	214,845	217,756	295,136	444,377
Europe:					
Germany	1,762,461	1,927,681	1,598,164	2,415,186	2,250,000
Austria-Hungary	1,057,692	1,167,959	889,373	1,509,870	1,335,000
France	833,210	804,308	622,422	1,089,684	755,000
Russia	1,256,311	1,206,907	953,626	968,000	1,450,000
Belgium	224,090	209,811	176,466	328,770	280,000
Netherlands	102,411	123,551	136,551	207,189	190,000
Other countries	325,082	441,116	332,098	415,000	440,000
Total Europe	5,561,257	5,881,333	4,708,700	6,933,649	6,700,000
Total beet-sugar production	5,763,416	6,096,178	4,926,456	7,228,785	7,144,377
Total cane and beet sugar production	11,819,141	12,182,327	11,678,996	13,862,118	14,305,823

[a] In long tons of 2,240 pounds, except in the case of European beet-sugar production, which has been retained in metric tons of 2,204.622 pounds, as originally estimated by Licht. Other data are mainly from Willett & Gray, but in the case of British India official estimates of production have been substituted.

[b] Not including the Philippine Islands, which are included under Asia.

[c] Equal to 484,971 short tons, or 1,359 tons greater than the production shown in table on page 104.

DEVELOPMENT OF CONDITIONS AND PROSPECTS FOR EXTENDING THE BEET-SUGAR INDUSTRY.

It may be stated that prospects for increasing the number of factories in the United States are somewhat peculiar. There never was a time since the inception of the industry when more communities were ready to embark in the beet-sugar industry. The farmers and business men are ready to sustain beet-sugar plants. On the other hand, capitalists are well advised concerning the availability of the proposed locations. From the standpoint of both the beet grower and the factory builder the tendencies to factory extension were never more pronounced.

Notwithstanding this situation, present indications point to fewer new factories for 1907 than were built during the past year. There are two main causes for this situation, and both are economic. The price of sugar during the 1906 campaigns of the sugar factories was very low. The market for the year has been somewhat erratic. In the western part of the country this has been caused largely by a change in the sugar refining which largely increased the output from the coast. Near San Francisco a new refinery was established under an arrangement with the Hawaiian planters. This controls most of the sugar coming from the Hawaiian Islands. In order to sustain the older refinery its managers brought in raw sugar from the West Indies and other places. This very much increased the amount of sugar coming from the west coast, brought on a stiff competition in the market, and affected the price of the beet sugar produced in the Rocky Mountain and coast States. It also affected materially the Missouri River markets, and consequently all beet sugar manufactured west of the Mississippi River. In the district west of the Mississippi are most of the places where the introduction of sugar factories is under contemplation. The probabilities are that the effect of the prevalent prices for sugar will only be temporary.

The second reason for hesitancy in factory building arises from some feeling of uncertainty regarding the permanence of the Government's present legislative policy as it affects this industry. Suffice it to say that conditions are ripe and popular feeling is strong for very much increasing the manufacture of beet sugar in this country whenever it appears reasonably certain that the present favorable policy of the Government is not likely to be disturbed.

There is no doubt that most of the well-established sugar factories are reasonably prosperous, but there is considerable significance in the term "well established." By it is meant the condition enjoyed by a factory having considerable experience and not hampered by unsolved problems; having a location where beet acreage can be secured readily, where the farmers are well versed in the methods of culture, where the soil normally produces a good yield of beets, where the by-products of the factory are consumed by the feeding interests, where intensive agriculture prevails, where the crop list of the district is conducive to rotation, where other industries thrive in cooperation with the sugar industry, where the freight rate is reasonable, where moisture through irrigation or rain is ample, and where regular markets and competent labor are available. Most of our sugar factories which have had five or six years' experience may be said to be well established. The favorable conditions are largely attributable to the factory's efforts. But it requires time to develop such conditions—longer under some circumstances than others. The difficulties are becoming less each year.

A few years ago "more beets" was the demand of the whole country. Last year there were only a few factories which did not secure the full acreage desired. The difficulty with a great number was overproduction. Such a condition tends to make the progress of the beet-sugar industry easy.

In my reports from time to time I have called attention to the greater tendency for the extension of the industry in the West. Everything considered, this is not due to superior facilities afforded. On account of the markets, transportation facilities, lesser cost of production, and many other things, the East has some advantages over the West. In the West there is more room to grow, less interference, and a united public demand for some strong industry capable of development work.

ARIZONA.

From time to time several valleys in this State have been tested experimentally in growing sugar beets. It may be said that the soils of these valleys as a rule are naturally adapted to the beet crop. The main difficulty with most of them is lack of railroads and incompetent irrigation, cropping here being dependent on irrigation.

At the present time there is one sugar factory in the State, an account of which has already been given. Until this factory shall have operated under more favorable auspices a further extension of the sugar industry in Arizona is somewhat doubtful, though during the past year another project was being considered near Phoenix.

CALIFORNIA.

The State is now actively engaged in beet-sugar production, standing second in amount produced.

Owing to the large amounts of sugar landed in the State for refining from outside sources, competition in the market is somewhat severe. This was especially true during the past season. In common with all other coast shipping interests, this industry is looking forward to the Panama Canal as a means of alleviating such conditions. It will affect the market for sugar and that of the other products in which it is used.

Two new factories were built in the State last year. Beets were grown for these under irrigation conditions. Most of the new districts under contemplation are also in irrigated districts. Beets are usually of high quality. Where sufficient water is available for irrigation and the land is properly handled and fertilized, the yields are good.

The following places in the State were under consideration the past season for establishment of new factories:

COMPTON.—At this place eastern parties were actively negotiating with home interests with a view to establishing a beet-sugar plant of

600 to 800 tons capacity. Plans contemplate both beet-sugar manufacturing and refining of Hawaiian raw sugar. In addition, the alcohol industry is under investigation as a subsidiary industry. Compton is south of and near Los Angeles and conveniently located for easy coast shipping and for the reception of raw sugar from Hawaii. It is in the vicinity of a well-established beet-growing district.

MARYSVILLE.—The district surrounding Marysville, on the Sacramento River, northeast of San Francisco, has been under active investigation during the past season by different interests. Plans contemplate a large acreage of land in connection with the plant. As yet nothing definite has been decided upon. Lands for growing beets would be watered by irrigation in connection with the Sacramento River.

JACINTO.—Jacinto is located in the vicinity of the lands growing beets for the factory at Hamilton. At this place a considerable acreage of beets was grown during the past year. Stimulated by favorable results, local interests are actively agitating for the establishment of a sugar factory at this place. They are negotiating with capitalists with this end in view.

TEHAMA.—During the past season beets were grown in this locality to some extent for the factory at Hamilton. The place is being more or less considered as an available point for a beet-sugar plant.

COLORADO.

An extended discussion of this State is unnecessary at this time. Beet growing for sugar factories is now carried on in most parts of the State. Where conducted to any considerable extent, favorable results are the rule. Progress in the installation of factories has been very rapid. Following the building of these plants has come a rapid development along agricultural lines. Many other industries have followed the establishment of the sugar industry. A number of canning factories, a plant for producing table sirup from beets, and several alfalfa-meal mills have been built and put in operation. The building of alfalfa-meal mills is under consideration at many points. The plants cost in the neighborhood of $50,000 each. In them alfalfa hay is ground into small particles. This product is compressed and shipped to the market in sacks, the same as bran. A demand for it is developing very rapidly in all parts of the country. Alfalfa is one of the main crops used in rotation with beets.

Notwithstanding the large number of factories already installed in the State, overproduction of beets was the rule. To meet this situation additional factories are under contemplation in districts which have grown large acreages of beets for established factories. Sugar manufacturers have been investigating and negotiating with local

interests. The farmers have either pledged the acreage or stand ready to contract for acreage sufficient to grow the beets. Indications point to a consummation of plans for building at the following places in 1907 or 1908:

BERTHOUD.—This place is in Larimer County in the beet-growing area tributary to Longmont and Loveland.

BOULDER.—Reporting on the conditions incident to the Boulder project, the secretary of the Boulder Commercial Association writes me as follows:

BOULDER, COLO., *December 31, 1906.*

DEAR SIR: Boulder County has been growing sugar beets for three or four years and keeping a 1,200-ton plant busy at Longmont in the eastern part of the county, but it was unable to grind all the beets contracted for this year, besides turning down 2,000 acres of contracts offered.

Boulder County has grown 71,800 tons of beets this year, the crop averaging between 15 and 17 tons per acre. Beets average 15 per cent of sugar and 80 in purity.

There are probably 10,000 or 11,000 acres of good sugar-beet land in the county. Our soil is mostly a sandy loam or sand and clay, very rich in potash and containing a good percentage of phosphoric acid. The source of irrigation is numerous mountain streams, furnishing abundant supply to store in reservoirs and conduct through the farming districts in large irrigation canals or ditches.

Yours, very truly, E. G. FINE, *Secretary.*

BRIGHTON.—Around this place beets have been grown for Longmont and Fort Collins. With reference to conditions and prospects for a sugar factory Mr. R. M. Barr, of La Salle, Colo., one of the company's special agricultural superintendents, reports as follows:

JANUARY 4, 1907.

DEAR SIR: I don't think there is a prospect of a factory this year, as this company does not intend to do any building this year, and there is no talk of building by any other company.

This past season there was about 700 acres of beets grown at this station, 450 for Greeley and 250 for a table-sirup mill built in 1906. We have grown beets for five years, and they are a profitable crop for both company and grower.

The tonnage of this station has averaged from 11 to 16 tons in the different years. Sugar contents and purity have come up to the requirements of the company on a contract requiring 15 per cent sugar and a purity of 80.

We have a variety of soils—sandy loam, black river bottom lands, heavy yellow and red clay lands—and all profitable beet-growing land if kept in a good state of fertility, which, with our Colorado alfalfa, can be easily done.

Yours, truly,

R. M. BARR, *La Salle, Colo.*

FLORENCE.—Beets have been grown in this district for the factory at Rocky Ford.

GREELEY.—Another factory is actively contemplated for this district.

JOHNSTOWN.—This place is located in Weld County, and the farmers have been growing beets extensively for near-by factories.

JULESBURG.—This place is in Sedgwick County, in the northeastern corner of the State. At this place a large irrigating ditch has just been completed, affording an abundance of water for irrigation. Beets have been grown for other factories in the State. A plant has been under contemplation at this place for several years and actively this year. During the past season about 1,300 acres were planted to beets, producing about 12,000 tons. These beets were shipped to other factories in the State. They tested 16 per cent of sugar, with purity coefficient of 82.

I have a recent report from Mr. J. Brant, a merchant of Julesburg, stating that announcement has been made of the purchase of a site for a factory and the signing of contracts for 5,000 acres of beets in 1907.

Mr. Mark Burke, a beet producer of this place, reports as follows:

JULESBURG, COLO., *December 29, 1906.*

DEAR SIR: Referring to your inquiry of December 24 relative to a beet-sugar factory at this place, I will say that we have a contract with responsible parties to build a factory in Julesburg to handle the 1907 crop of beets, and to begin construction of the same not later than February, 1907.

We have grown and harvested about 2,000 acres in 1906, which yielded from 10 to 18 tons per acre. We get $4.75 per ton (flat rate), so we do not know how much they tested; but we had a test made in 1904 that showed 18.1 per cent of sugar. We have 28,000 acres of land under reservoir irrigation.

Respectfully, yours, MARK BURKE.

LA JARA.—This is in the southern part of the State. A factory has long been under contemplation at this place. Referring to prospects and conditions at La Jara, Mr. D. E. Newcomb reports as follows:

LA JARA, COLO., *December 27, 1906.*

DEAR SIR: Experiments have been carried on in sugar-beet raising for a number of years. They have done well, yielding as high as 20 tons to the acre and testing from 16 to 18 per cent of sugar with purity ranging from 83 to 85. The only obstacle to contend with is that the beets will nearly all have to be siloed on account of our short seasons.

Our soil varies from a rich black loam on our river bottoms to a light sandy loam on our uplands. Our valley is about 100 miles long north and south by about 40 miles wide, and my judgment is that at least two-thirds of the valley will grow excellent sugar beets, or any other kind of roots. The valley is well watered from the Rio Grande River, Conejos, Alamosa, La Jara, and other streams. A reservoir on the Alamosa River is now under construction, which will cost, when finished, about $350,000. This will furnish water for about 30,000 acres. Two reservoirs on the Conejos and two on the Rio Grande will soon be under construction. Water and soil are all right.

Yours, very truly, D. E. NEWCOMB.

PLEASANT VALLEY.—This place is near Greeley and Longmont and has been growing beets for those factories.

PUEBLO.—Pueblo is on the Arkansas River. Beets have been grown in this district for the factory at Rocky Ford. A number of interests are closely investigating its conditions. Announcement has been made that a factory is to be constructed there in 1907.

I asked Mr. C. B. Schmidt to make a report on conditions at this place. Mr. Schmidt has been interested in a large body of land and actively investigating conditions in the vicinity for some time. He has been one of the chief workers for the introduction of the beet-sugar industry at this place. He reports as follows:

CHICAGO, *January 4, 1907.*

DEAR SIR: At Pueblo I had charge of a body of 20,000 acres of land irrigated from the Bessemer irrigating canal, and while there during the past twelve years have paid much attention to the beet-sugar industry in Colorado. Several years of experimental beet planting upon our lands eventually secured the erection of the first beet-sugar factory in the Arkansas Valley in Colorado. It was built by the American Beet Sugar Company, Henry T. Oxnard, president. The industry has developed to such an extent since 1899 that now 15 sugar factories are in operation in the State of Colorado, 5 of which are located in the Arkansas Valley between Pueblo and the Kansas State line, and a sixth is being built at Las Animas. There is also a prospect for a seventh factory to be built near Pueblo, but it may not be done before 1908.

The general average tonnage grown in the Arkansas Valley is 12 tons per acre, but good farmers reach 25 and even more than that. The factories pay a price of $5 per ton, flat—that is, irrespective of sugar contents. During the first five years since the establishment of the industry in the Arkansas Valley the factories paid for the beets on a sliding scale, to wit, $4 for beets testing from 12 to 14 per cent of sugar and one-third of a dollar more for each additional per cent. The growers, however, insisted upon a flat price, and the sugar manufacturers concluded that they could afford to pay $5 flat.

The beets grown in the Arkansas Valley in Colorado have averaged between 16 and 17 per cent of saccharine matter, with a coefficient of purity fluctuating between 80 and 90.

I think the lands which I had under my charge along the Bessemer irrigating ditch in Pueblo County compose the banner section for sugar beets in the Arkansas Valley.

Very truly, yours, C. B. SCHMIDT.

SALIDA.—With reference to conditions in the Salida district, Chaffee County, Mr. George S. Nelson, secretary of the board of trade, reports as follows:

SALIDA, COLO., *December 24, 1906.*

DEAR SIR: The board of trade distributed some 100 pounds of sugar-beet seed among a few of our farmers, but the results were not all that we expected, owing to various reasons, one of which was that they called for the beets just at a time when the ground was covered with a foot of snow, which was a bad thing for our showing. Also a want of care in cultivating gave our efforts a setback. We sent four samples of six beets each to the Grand Junction factory, and they registered as follows:

Results of beet growing near Salida, Colo., in 1906.

Sample.	Weight of beets.	Tare.	Sugar in beets.	Purity coefficient.
	Lb. oz.	*Per cent.*	*Per cent.*	
No. 1	1 13	12	15.4	79.5
No. 2	2 4	16	13.4	77.6
No. 3	2 4	13	13.7	77.2
No. 4	3 3	9	12.9	80.0

You will note that these beets are quite low in sugar and also in purity. I suppose that these beets were pulled right after the snowstorm. If that is the truth, that is one of the reasons for the poor quality, as wet weather will cause beets to drop in sugar and also in purity, but they will jump back again as soon as the ground dries out again.

We got no report on tonnage or cost of growing. We hope to do better next season. We think acreage could be assured for a factory, but have made no efforts in that direction as yet.

Very truly, yours, GEO. S. NELSON.

LAS ANIMAS.—At this place a factory of 700 tons capacity will be built. This plant will be constructed by the American Beet Sugar Company. The contract for its construction has been let. For some time beets have been grown for the factory at Rocky Ford and others near it more recently built. The establishment of a plant at this place will increase the number in the chain of factories along the Arkansas River to 6. The contract calls for its completion in time for the campaign of 1907.

OTHER POINTS.—In the newer parts, depending largely upon experimental data, the following places have been investigated, and indications point to the desirability of installing the beet-sugar industry in the near future: Argo, in Denver County; Durango, in La Plata County; Wellington, about 12 miles north of Greeley.

IDAHO.

At the present time Idaho has 4 sugar factories operating in the State, scattered along the Snake River from the western to the eastern part. These plants have given great impetus to agricultural development. There are several places in the State under serious consideration for building beet-sugar plants. It is anticipated that some of these projects will materialize in the near future.

During the past season factories in operation received a large tonnage and were worked to their capacity, the campaigns lasting from 80 to 120 days. The results of this season have done much to stimulate the industry in the State.

The State is developing very rapidly. Irrigation facilities, fruit culture, and the growing of alfalfa, small grain, and potatoes are extending rapidly. Indications point to the need of other sugar factories. The projectors of factories in Idaho are well advised of the needs of the industry. This experience was gained through a long, intimate acquaintance with it in Utah. There is no tendency to overdo the matter or overreach the capabilities of the State for sustaining the sugar industry. Factories will be built as fast as the business status will warrant.

PAYETTE.—When the factory was installed at Nampa by the Utah Sugar Company it entered into an arrangement with the business and farming interests of Payette. It was decided that the Payette district should grow beets in 1906 for the factory at Nampa, and as

soon as sufficient acreage could be procured around Payette another factory would be constructed there. During the past season around Payette was grown a large acreage, results of which were highly satisfactory to the farmers and to the factory management. Under this agreement, construction of a factory will commence in 1907, to be ready for the campaign of 1908.

ILLINOIS.

During the past season the interest of the beet-sugar industry in the State was centered around Rockford, Sterling, and Geneseo.

GENESEO.—At this point more interest has been manifested than at any other. In the town an active organization of business interests is promoting the beet-sugar project. It has been conducting negotiations with capitalists and beet-sugar men for the past two years. This place is located in one of the best-developed agricultural districts in the State. The soil is a dark sandy loam, and very productive. As a rule the farmers are of the better class. Under the direction of this organization considerable beets were grown in the district and shipped to sugar factories in Wisconsin and Illinois.

STERLING.—The editor of the Gazette, Sterling, Ill., reports to me with reference to the sugar industry at that place as follows:

STERLING, ILL., *December 24, 1906.*

DEAR SIR: There have been no definite steps taken in this section to develop the production of beet sugar. The tests made under the supervision of the State agricultural experiment station at Urbana some years since proved that this territory is well adapted to the growing of beets.

As I remember, there were 20 specimens of beets grown some four or five years ago in Whiteside, Lee, Carroll, Ogle, and Henry counties, half of which came from within a radius of 15 miles of this city. None of these analyzed less than 12 and some 15 per cent of sugar. One specimen I remember that was sent from the vicinity of Woosung, a village in Ogle County, a dozen miles north of the city, showed 18 per cent of sugar. The published report says that "it has been conclusively proven that this section is well adapted for the growth of beets for the manufacture of sugar."

We have a rich community, where land sells for $125 an acre, within 5 or 6 miles of the town. All of the roads are macadamized, and we have an abundant supply of excellent water and a surplus of water power practically developed. A Government canal (the Illinois and Mississippi) connects with the Illinois River and the coal-mining districts, which assures a low price for fuel. There is an excellent quality of lime within a few miles of the city on the bank of the river which could be transported in barges to a factory at a minimum of expense. The railways that enter the city cover the greater part of this county, and there are good connections with neighboring counties, where a considerable acreage should be secured.

The people here will take the matter up now, I think, if they have some encouragement. I think they would make an effort to secure the contracts for the necessary acreage and probably do something further to secure the location of a mill at this point.

Yours, most respectfully, E. S. HOOVER.

IOWA.

During several years many places in Iowa have been under discussion and investigation with a view to the introduction of the beet-sugar industry. At several points this subject evolved more than usual interest. Beets were grown experimentally, organizations were effected, local interests were canvassed, negotiations with capitalists and beet-sugar interests were actively conducted.

The districts which received particular attention were those around Des Moines, Davenport, Clinton, Waterloo, Fort Dodge, Cedar Falls, Mason City, Clear Lake, Muscatine, Missouri Valley, Sioux City, and Storm Lake.

For the factory at St. Louis Park, Minn., for the first few years considerable acreage was grown around Cedar Falls, Waterloo, and Storm Lake.

Near Missouri Valley for the first two or three years a large acreage was grown for the plant operated at Leavitt, Nebr. One season the contracts around this place reached 1,200 acres.

In addition to these practical demonstrations the State has been very thoroughly tested through small beet plats from year to year under the direction of the State experiment station at Ames. Through all these the conditions of the State have been pretty well ascertained. It may be said there is no district in the United States better adapted to this industry than the northern half of Iowa. It has many advantages. Commercially the field is very inviting to the beet-sugar industry. Railroads connect its cities and towns and penetrate its rural districts in every direction. There is not a county in the State without a railroad; many have several. Its sugar consumption is large. Natural conditions are as well adapted. Crops are regular and the soil productive. Dairying and stock feeding are largely developed. At present considerable interest in the subject is manifested at Fort Dodge.

WAVERLY.—Additional facts bearing on the State's adaptability to the industry will be more practically demonstrated by the actual results of a sugar factory. During the past season 1,200 acres of beets were contracted here for the factory at Chaska, Minn. The owners of that factory also have a plant at Bay City, Mich. It is one of the five originally established in a limited beet-growing district tributary to Bay City and Saginaw. It was found impossible to procure enough beets for all of them and the plant referred to remained idle for several years. Its owners made a proposition to the local interests at Waverly looking to its removal to that place. They stipulated that a certain acreage of beets be grown at Waverly in 1906 for the Minnesota plant; that 3,600 acres be contracted for by the farmers around Waverly for 1907 for a plant to be installed

there, and that Waverly capitalists invest a certain amount of capital in the stock of the new company. On these conditions the plant would be moved to Waverly.

The stipulated acreage for this year was grown around Waverly, and the results were exceptionally good. I examined the beet fields the latter part of June, and, for a first attempt, I never saw better beets at any other place in the United States. Contracts for 3,600 acres were procured as stipulated for the campaign of 1907. Contracts have been made for the removal of the Michigan plant to this place. Dismantling to that end is now proceeding. The foundations and railroad side tracks at Waverly were begun the first of the year. The factory will be installed and ready for the campaign of 1907.

Waverly is an exceptionally well-developed agricultural part of Iowa. Its farming element is composed of the industrious, frugal class. No better place could have been found for the introduction of the industry in the State. The Waverly factory is incorporated under the name of the Iowa Sugar Company, with a capitalization of $500,000. Its capacity will be 500 tons per day.

The work of promoting the industry at Waverly and growing the beets for the factory at Chaska, Minn., was under the active management of a local business men's committee. One of the active members of this, Mr. G. O. Van Derveer, reports on results the past year and the status of the sugar factory building at that place as follows:

WAVERLY, IOWA, *December 28, 1906.*

DEAR SIR: We have landed our beet sugar factory, and the contractors are now at work breaking ground. The contract has been let. The articles of incorporation have been executed and filed with the secretary of state.

In regard to growing beets, I will say that we had contracts for something like 1,200 acres this year, and the beets grown were shipped to Chaska, Minn. In all, 202 carloads, amounting to 10,474,720 pounds, were shipped. In general, I think the farmers were fairly well satisfied with the industry. Some, of course, had practically no beets at all, but the majority had 10, 12, and 14 tons per acre; one party had 24 tons, two had 22 tons, and a few more had 20. Of course these beets were all tested at Chaska, consequently we have no data as to sugar contents and purity. We have somewhere between 3,700 and 4,000 acres of beets contracted for now for the years 1907 and 1908, which of course assures the factory a fair campaign, and we have no doubt that when the Bremer County farmer becomes thoroughly acquainted with this industry and the profits therefrom he will take very kindly to the same.

During last summer there was not a man, woman, or child that wanted to work but had the opportunity to help in the beet fields, and that with the very small acreage we had planted the past year. The sugar people had several men here looking over conditions, soil, etc., and were well satisfied with them. They seem to think that Iowa—at least this section—is well adapted to raising sugar beets. In fact, Fort Dodge business men have run an excursion to

Waverly to investigate the beet industry, with a view to securing the second factory which the eastern parties connected with our company have said will be built in Iowa.

Yours, very truly, G. O. VAN DERVEER.

KANSAS.

Experimentally beets have been grown in Kansas for a number of years. As a result of these tests its general conditions have been considered rather unfavorable. In this State, as in Nebraska, are two distinct conditions in relation to farming. In the eastern half crops are grown by rainfall, but the amount of precipitation gradually declines from east to west, the western portion being semi-arid. Crops depending upon rain are not so sure. Conditions are similar to those in eastern Colorado, where irrigation is necessary.

In this western section beets grown experimentally, or as regular field crops for sugar factories in eastern Colorado, have proven of high quality. Where proper cultivation is given and sufficient water is obtained the yield is generally good.

The district giving most attention to the beet-sugar industry for the last few years are the lands tributary for irrigation purposes to the Arkansas River. The adaptability of these lands for beet culture has been thoroughly established. Under the encouragement of a State bounty, a considerable tonnage of beets has been grown from year to year for the factory at Rocky Ford, Colo.

During the past season Colorado capitalists established a factory in the western part of the State, at Garden City, very much increasing this year the acreage grown in that section. Results were highly satisfactory. In connection with the plant the company owns about 27,000 acres. It plans to utilize this entire acreage in sugar-beet production and crops grown in rotation therewith. It has announced the policy of building three other factories in the vicinity of the first one, drawing upon its owns lands for its acreage, and upon other lands watered from the Arkansas River. It has already built up a competent beet-growing area in the vicinity of its present factory. The other factories will be needed in the next two years. These plants will be in the vicinity of Garden City, Deerfield, and Lakin.

In beet culture the experience of western Kansas is that of other places. More experience develops an upward tendency in yield and profits. I quote from a recent report of Hon. F. D. Coburn, secretary of the Kansas State board of agriculture, as follows:

In 1901 the average profit per acre was reported at $28.48, while the highest individual profit per acre was $43. In 1904 one grower in Rawlins County, during his first year, reported profits of $85.50 per acre. In showing the increase in tonnage it may be stated that in 1901 the average yield per acre was 5.10 tons; in 1902 it was 9.68 tons, an increase of over 90 per cent. The 1903

crop was practically a failure, owing to a spring freeze. In 1904 the average yield per acre was 13.51 tons, an increase over that of 1902 of about 40 per cent, and more than 160 per cent over that of 1901; and in 1905 there was a creditable tonnage per acre.

The above averages were obtained where the acreage was small. The results of the past season furnish a better test, as they show averages from the entire campaign, in which 70,000 tons of beets were worked. The average of the sugar contents was 16 per cent, the average purity 84, the average tonnage per acre 11⅛. This indicates superb conditions for the factory, and that the average farmer growing the beets received $58.33 gross per acre.

In his report issued in September, 1906, Secretary Coburn estimates the cost of growing beets in Kansas as follows:

Cost of growing beets in Kansas.

	Per acre.
Plowing	$1.00
Seed, 20 pounds	2.00
Planting	.50
Bunching and thinning	6.00
Hoeing and cultivating	10.00
Harvesting and topping	8.50
Interest on land, irrigation, hauling, general charges	9.50
Total	37.50

This estimated cost per acre, $37.50, is about the ordinary cost of producing sugar beets in any well-regulated irrigation district. Using this cost factor, the average farmer growing beets for the Garden City factory this season received $20.83 net profit per acre. If such results as these can be achieved in western Kansas the first year, sugar production certainly appears to have a bright future.

The average sugar content and purity of the beets maintained in this district the past season throughout the campaign is certainly very flattering to the district. The reception of 70,000 tons by it the first year augurs much for the future of the industry in that section of the State. The factory management and the farmers growing the beets appreciate this. Every indication points to the building of one of these sugar factories in 1907 and the other two in the near future.

MINNESOTA.

During the past summer there has been considerable agitation in favor of building more sugar factories in the State. Several years' experience in the industry has developed many conditions favoring it. The soil is especially adapted. As a rule it is a sandy loam, quick and responsive, and adapted to a low cost of beet culture. It has an abundance of pure water in its running streams and lakes. It has transportation lines and markets. These conditions are appreciated generally by the business and farming interests of the State.

In almost any part of the State where lands are cultivated beets of sufficient quantity and quality can be grown. The lower half of the State is better adapted for manufacturing.

The places receiving special attention as possible locations of beet-sugar factories were Watkins, Austin, and Winona. All of these places are very favorably located for manufacturing and shipping purposes. They are in the midst of fertile, well-developed, progressive farming districts.

MONTANA.

In my reports for several years I have discussed conditions adapted to the beet-sugar industry in this State. Throughout its valleys many experiments have been conducted from time to time. It has been under investigation by beet-sugar capitalists of Colorado and Utah. All are agreed that its natural conditions are especially favorable to the sugar industry.

This industry is destined to play an important part in the State, as it has already done in Colorado. Its installation simply awaits the development of conditions—the irrigating ditch, the railroad, reclamation of the soil, and the presence of the settler.

Recently irrigating facilities were very much increased in the vicinity of Billings, and a sugar factory was built.

There is a number of valleys in the State in which improvements are proceeding very rapidly, more land is being reclaimed, and the country is fast settling. Representatives of beet-sugar interests have had these places under investigation and are encouraging improvements. Sugar factories are definitely under consideration. Local interests are ready to furnish the acreage; beet-sugar companies are ready to build the factories. Local companies or organizations have the matter definitely in hand.

Those places more generally spoken of are Conrad, in Teton County, a farming district irrigated from the Marias River; Fergus, in the upper part of Fergus County, in the central part of the State, near the Missouri River; Harlem, Chinook, and Montauk, in the Milk River Valley, in Chouteau County, and Hamilton, in the valley of the Bitter Root River, in Ravalli County. All have been under serious consideration, and negotiation has been going on between those locally interested and representatives of companies producing sugar in Colorado, Michigan, and Utah.

With reference to conditions around Chinook and prospects of a sugar factory there, I publish a report made by Mr. L. V. Bogy as follows:

CHINOOK, MONT., *December 27, 1906.*

DEAR SIR: This community is very much interested in the sugar-beet industry. The past season our commercial club offered prizes for the first, second, and third best quarter acres of sugar beets grown in this vicinity. A number of

farmers competed, and analyses showed as high as 20 per cent of sugar and 88 coefficient of purity, and the tonnage ran as high as 24 tons per acre. The average was about 17½ per cent of sugar and 85 purity. Yields averaged 18 tons per acre. The cost of growing per acre was about $40.

We have a Sugar-Beet Growers' Association organized and incorporated for the purpose of taking up the matter with proper parties, with a view to getting a beet-sugar factory located here. From all data we can gather, we believe there is no more favored spot in the United States than this for the successful culture of the sugar beet. Our soil seems to be particularly adapted for growing beets high in sugar content and purity and with large yields. We are taking the question up in earnest, and, while we have quite a large acreage secured for sugar beets, we expect to add to it very materially and believe we will be in shape for a factory to work the 1908 crop of beets into sugar.

Yours, respectfully,

L. V. BOGY.

With reference to conditions around Harlem and the prospects of building a sugar factory there, I publish a report made by Mr. W. E. French, secretary of the Milk River Sugar-Beet Association, as follows:

HARLEM, MONT., *December 30, 1906.*

DEAR SIR: Referring to the sugar-beet industry, I beg to state that we are at work at the present time securing subscribers to contracts for the purpose of securing a factory in 1908. Milk River Valley is adapted to beet culture, the soil being rich sandy loam. We are negotiating with the Amalgamated Sugar Company, of Ogden, Utah, for the establishment of a factory as soon as we have the acreage signed up.

Fort Belknap Reservation is in the heart of Milk River Valley, and we have one of the best sections of the United States for sugar-beet culture.

Respectfully, yours,

W. E. FRENCH.

BOZEMAN.—Bozeman is in Gallatin County. Its cultivated lands are in Gallatin Valley. At this place is located the State Agricultural College and Experiment Station. This district has been thoroughly tested by the experiment station for a number of years. Results have always indicated good yields and beets of a high quality.

This point had been in favor for the location of a factory for some time, even before one was located at Billings. In this district were grown beets during the past season for the Billings factory farther east. This small place raised $28,000 for the purpose of promoting the beet-sugar industry. It has purchased a site of 140 acres; it has the right of way for a switch, and has secured contracts with the farmers for over 5,000 acres of beets. It has an agreement with the Amalgamated Sugar Company to build a factory at this point upon the completion of these conditions. Farmers' contracts were based upon the factory's guaranty of sufficient labor in the fields. Upon this now depends building of the factory in 1907.

In order to furnish some information relative to conditions and prospects at Bozeman, I wrote Hon. C. S. Hartman, of that place,

who is prominently connected with the citizens' organization for establishing a beet-sugar factory. In response I received the following:

BOZEMAN, MONT., *December 27, 1907.*

* * * We have been working earnestly to secure a sugar factory here at Bozeman for the past year, having already secured contracts for over 5,000 acres signed by the farmers of our valley. We expected to have the matter settled in regard to the building of the factory before this, but at present we are more in the dark than ever. In answer to your question—"To what extent have you experimented or practically grown sugar beets?"—I will say that we have been experimenting with sugar beets here in the Gallatin Valley for the past fifteen years, and this year there was quite an acreage grown and shipped to Billings, some farmers growing as high as 15 acres. The results have been highly satisfactory. We are confident that we can raise as good a beet and as large a tonnage as they can in any place in the United States. The tonnage will run from 15 to 25 tons per acre, the sugar contents from 15 to 18 per cent, and the purity from 80 to 90.

We have here in the Gallatin Valley something like 120,000 acres under irrigation and about an equal area is farmed dry. The nature of the soil varies from heavy black to very light sandy. In fact, I think we have the greatest variety of soil of any valley in the Northwest, plenty of water, and an irrigation system that is unsurpassed, which has been developed and handled by men thoroughly experienced in that line of farming.

Respectfully, C. S. HARTMAN.

In reference to the status at Bozeman, I publish a report made by President J. M. Hamilton, of the State agricultural college, located at that place:

BOZEMAN, MONT., *January 8, 1907.*

DEAR SIR: In answer to your inquiry about the Bozeman beet-sugar factory I will say that contracts were secured with the farmers for 5,000 acres of beets. Arrangements were made with the Amalgamated Sugar Company, of Utah, to erect a factory during the year of 1907. The contracts with the farmers required the factory to guarantee labor. This they have been unable to do so far, and now it looks as though the factory would be delayed. The capital is ready, but the labor is lacking.

Our experiment station has been sending out seeds and analyzing beets for some ten years with very flattering results. Nothing has been published of the work for the past three years.

The Gallatin Valley has about 100,000 acres of first-class land, mostly sandy loam, under irrigation. It is the best watered valley in the State of Montana, being surrounded by high mountains covered all the year with snow. Most of our streams have their sources near the Yellowstone National Park.

Yours, truly,

J. M. HAMILTON.

NEBRASKA.

At the present time there is very little consideration given to installing sugar factories in the eastern part of the State. In this section there are now two sugar factories and the bulk of the beets for both come from the western part of the State.

In the last few years facilities for irrigation have greatly developed. The ditches connect with the North and South Platte and the Republican rivers. In this irrigation section of the State about 11,000 acres were planted last year, the principal acreage being around North Platte, in Lincoln County, and McCook, in Redwillow County. There has been considerable negotiation between parties locally interested and the managements of the two established factories in the State regarding the building of plants at these points. Irrigation facilities are rapidly extending. The districts produce sugar beets, alfalfa, small grain, and potatoes. If factories were to locate here, the beet-growing area would be very much extended. It is over 100 miles from Grand Island and over 200 miles from Leavitt. If it pays to produce this raw material and ship it so far to these factories, the beet-sugar industry would certainly be working at a greater advantage if located in this large, fully developed beet-growing district. For absolute assurance of moisture here, irrigation is necessary. During the past two years this district has received nearly enough rainfall for growing crops, requiring very little irrigation. There will be other seasons, no doubt, of which this can not be said.

The management of the factory at Leavitt had an agreement with the business men and the farmers of the North Platte area to build a factory here during 1906. Had not this company fallen into difficulties, leading to a receivership, a sugar factory would undoubtedly have been installed here the past season. The district has been investigated by others. There is every indication that either one of the present companies operating in Nebraska or some outside company will build a factory at North Platte soon.

The other places that have been under investigation for several seasons are McCook and Culbertson, on the Republican River, in Red Willow and Hitchcock counties, in the southern part of the State. Around these points are grazed many sheep and cattle, and considerable alfalfa is grown for feeding and grinding into "alfalfa meal."

OHIO.

The factory in operation at Fremont has done much to promote this industry's progress in Ohio. The beet-growing area in its vicinity during the past season greatly overran the capacity of the factory. The plant at Blissfield, Mich., near the southern border of Michigan, receives many beets grown in its vicinity in Ohio. The two have built up conditions necessitating an additional factory. Defiance has been under consideration for this purpose. The management of the factories at Blissfield, Mich., and Fremont, Ohio, have under consideration plans for the establishment of a plant at

Defiance. With reference to the conditions and prospects here, I publish a report made by J. J. Thieroff, as follows:

DEFIANCE, OHIO, *January 7, 1907.*

DEAR SIR: As regards the building of a sugar factory here, we don't know any more about it than we did last summer when you were here. As to the practicability of growing sugar beets in this section, this has been our first season in Defiance and Paulding counties and also the eastern part of Allen County, Ind., except that about eight or nine years ago some beets were grown in an experimental way for the United States Department of Agriculture.

As to yield, we had a very unfavorable season to contend with. In the spring in the greater part of Defiance County we had a severe drought. We had a hard time getting the soil in such shape that it was possible to plant, and then the continued drought hindered the beets from sprouting. The dry spell was not broken until July 3, and the result was that a large portion of the seed did not come up until after the 4th of July and considerable of the area had to be replanted.

The above has reference to Defiance County generally. In Paulding and Allen counties the weather conditions were more favorable. They had a greater rainfall. The tonnage per acre in the last-named counties ran all the way from 12 to 18 tons per acre, while in Defiance County it will be, on an average, about 11 tons. At harvest we had but very little sunshine and lots of rain, which very much decreased the percentage of sugar, so it will run about 13 per cent and the purity about 83.

Our soil is mostly the so-called "elm soil;" we have a large area of it, and there is surely no question that in a favorable season we can grow a large crop of beets and of good quality. Under the unfavorable weather conditions the past season we have grown a very profitable crop.

Yours, very truly, J. J. THIEROFF.

UTAH.

There are two or three places in Utah at present where conditions are sufficiently matured to sustain sugar plants. The Lehi factory has developed a considerable acreage of beets in Sanpete and Sevier counties. Should a factory be located in each of these counties there is ample area already developed to sustain them. For some time farmers and business men of this southern district have been in negotiation with the management of the plant at Lehi and other beet-sugar interests for the purpose of securing a factory. The Utah Sugar Company has had the matter under advisement for some time. It has announced that the company will build at least one factory to accommodate this territory somewhere near the boundary line. Propositions have been received from other interests to the same end.

The points considered in this district are Gunnison, of Sanpete County, and Richfield and Elsinore, of Sevier County. Water for irrigation in these two counties is received from the Sevier River.

North of Salt Lake there is a large irrigated district watered from Bear River. Beets are grown here for the three factories at Garland, Logan, and Lewiston. Beet culture has developed to such an extent that another factory is demanded here. One is under active consid-

eration near Trenton. Business and farming interests in this community are assured that a factory will be built as soon as sufficient acreage can be signed up. This is in the northwestern part of Cache County. A new irrigating ditch has just been opened up developing about 30,000 acres of land. A sugar factory in this northern district and one or two in the southern part of Utah are anticipated soon.

WASHINGTON.

For several years there has been considerable agitation tending to further increase the number of sugar plants in Washington. Most places recently considered are in the irrigated districts, principally those watered from the Yakima River. For the plant now in operation at Waverly beets are grown, as a rule, under rainfall. The principal rainfall in eastern Washington comes in the winter and early spring. This is found sufficient for small-grain production. The growing period of sugar beets is longer. It is found, through experience in growing beets for this factory, that the rainfall is hardly sufficient for beets. There is too much tendency to drought in July and August. Often the tonnage is cut materially on this account.

It has appeared likely several times that a plant would be established at North Yakima. Around this place has developed an extensive agricultural and fruit-growing district, amply watered by irrigation. The soil is productive and beets of a high quality are produced. Up to the present time most of the projects have fallen down for lack of capital.

North of this, on the Yakima River, in Kittitas County, during the past season, Ellensburg has been under serious consideration by capitalists of Seattle. The proposition was made to those locally interested to establish a plant at this place, providing sufficient acreage could be contracted. For a while this project appeared very probable. It is still under consideration. The locality has conditions well adapted to the sugar industry.

With reference to the prospects for a sugar factory, development work, and conditions at Ellensburg, I publish a report including analytical data regarding beets grown there during the past season:

ELLENSBURG, WASH., *December 31, 1906.*

DEAR SIR: We feel sure of ultimately getting a sugar factory located here, and hope to have it built within the next year or two. We have raised sugar beets for the past two years, with most gratifying results as regards tonnage, sugar content, and purity. I inclose herewith report of tests made by the chemist of the State agricultural college on beets raised during the year 1906. I have not a report of tonnage at hand, but the average yield for both years runs about 20 tons per acre. We have in this valley about 80,000 acres of irrigated land suitable for raising sugar beets. Most of this land has abundant water for irrigating purposes. Conditions as regards markets and for obtaining labor are ideal.

Ellensburg is situated about 125 miles from Seattle, the best market on the Pacific coast north of San Francisco. We have no labor organizations to interfere with the importing of suitable help for weeding and thinning beets.

Respectfully,

C. W. JOHNSONZ.

Results of tests of sugar beets at Ellensburg, November 30 and December 1, 1906.

Grower.	Sugar in beets.	Purity coefficient.	Grower.	Sugar in beets.	Purity coefficient.
	Per cent.			*Per cent.*	
Dallas Kinkade	14.1	88.2	Josie Stevens	17.1	91.3
Ben Rader	23.6	93.5	Guy Dunning	16.6	85.3
May Stevens	17.7	90.0	Harry Rice	14.1	81.1
Sylvan Thomas	17.5	88.5	Ina Van Nostran	15.4	90.0
Maud Stevens	17.6	87.3	Jeff Fortney	18.3	89.3
Jesse Newman	16.6	89.9	George Page	20.8	93.3
Rua Beall	19.7	90.8	Cora Jonas	18.5	90.7
Cecil Hutchinson	16.6	86.1	Horace Briggs	19.4	90.7
Raymond Kellicut	20.5	90.0	Selena Preece	17.5	85.0
Millie Van Nostran	17.6	88.9	Mary Preece	15.6	82.0
Marshall Malone	21.2	92.1	Iris Burns	18.0	85.9
Bob Ballard	23.6	93.5	Vida Bollman	17.9	84.3
Winnie Mudd	17.5	89.3	Mack Reece	15.1	84.6
Willard Sheldon	16.8	88.5	Harry Hayes	16.9	87.6
Hazel Berry	17.8	87.0	John Sorenson	16.0	84.0
Clara Sheldon	19.4	86.8	Charles Indemuhle	15.6	86.3
Sadie Mudd	13.9	77.2	Dora Hayes	17.7	84.5
Jessie Mudd	17.0	84.4	Bertha Sorenson	16.7	83.0
Dorothea Sorenson	17.0	85.3	Milo Sheldon	17.9	84.7
Flora Preece	13.7	75.3	Willie Cheney	16.2	90.5
Ruth Barkley	16.6	85.2	Chalmer Cobain	20.9	90.0
Beckwith Hubbell	18.2	87.6	Mabel Ames	20.2	89.0
John Pieroth	17.9	86.2	Helen Barkley	18.1	86.4
Frederick Munz	17.0	85.2			
Ida Anderson	18.4	84.7	Average	17.6	85.3
August Hartman	17.8	89.0			

WISCONSIN.

Wisconsin has many conditions which admirably adapt it to the sugar industry, which is gradually developing in the State. Four large factories are now in operation. In the State are many lakes, springs, and running streams of the purest water. It is one of the best developed States in intensive agriculture. Its dairying and creamery interests are quite extensive. It has canning and other interests depending upon the farm for raw product. It grows considerable tobacco. It has an intelligent, progressive farming population; cheap, abundant transportation facilities, both by water and by railroads, and has many places admirably adapted to the beet-sugar industry.

As fast as conditions will warrant, other factories will be built in Wisconsin. The places under consideration at the present time are Green Bay, Edgerton, Lancaster, Marshfield, Sturgeon Bay, Fond du Lac, and Prairie du Chien.

Below I give a report by E. C. Amann on conditions and prospects of the beet-sugar industry at Prairie du Chien, Wis.:

PRAIRIE DU CHIEN, WIS., *December 29, 1906.*

DEAR SIR: As we have not received the complete returns we are unable to give you the complete details concerning the beets grown by this association.

We expect by January 20 to be able to give you the details. We have already enough to pay all expenses, and we think that we ought to receive a profit of about $1,000. We had a larger acreage than any other grower in the State. Our sugar test ran from 12 to 15½ per cent, and we think the yield will average about 15 tons per acre.

It has been intimated to us that the United States Sugar Company, of Madison, is contemplating the erection of a factory here in 1908.

Very truly,

BEET GROWERS' ASSOCIATION,
Per E. C. AMANN.

WYOMING.

Wyoming's conditions, natural and commercial, are quite similar to those of Montana, but it is newer and less developed. What it needs is railroads, irrigation, settlement, and soil development. It has many running streams draining its mountains, carrying the melted snows and early rains, and many fertile valleys tributary to these streams. Irrigation is proceeding very fast to their development. At present the irrigation is largely conducted by means of running water. In the mountains in the western part of this State are collected the snowfalls of winter and the rainfalls of spring. The future will see these impounded and gradually conducted to the soil as needed, greatly promoting and extending the agricultural resources of the State.

As in other mountain States, the soils of Wyoming produce in abundance many field crops, principally alfalfa, potatoes, and small grain. Grazing is the principal feature of its stock interests. Experimentally its valleys have been tested for adaptability to beet culture. Under proper methods of culture, with sufficient water, the yield is heavy and the quality is excellent.

Realizing the part the sugar factory has played in the development of Colorado, every valley in the State of Wyoming susceptible to cultivation and cropping has been under investigation. Irrigating and railroad projects tapping its fertile valleys are contemplated or projected. Capitalists from all parts of the country have inspected these valleys. Managements of great railroad lines have become interested. Men interested in the beet-sugar industries of Utah, Colorado, and Michigan have participated.

Back of all these projects of irrigation, railroad building, and town sites is the sugar factory. Some of these factory projects are almost to the point of materialization. Capitalists have made actual propositions to build factories. Local organizations have accepted, or are actively striving to meet the conditions imposed. Of such are the projects contemplated for Sheridan, in Sheridan County, Tongue River Valley; Worland and Lovell, in the Big Horn Valley, Big

Horn County. Other places under consideration to a considerable extent are Burlington and Cowley.

With reference to conditions and prospects of the beet-sugar industry at Sheridan, I publish a report made to me by Mr. W. S. Metz:

SHERIDAN, WYO., *December 28, 1906.*

DEAR SIR: We have all the arrangements under way for the installation of a sugar factory. The beet-sugar people from Colorado Springs have purchased a large tract of land contiguous to the town of Sheridan suitable for the cultivation of sugar beets. They are contracting for a site for the factory and have taken a franchise for an electric railway through the town of Sheridan and through the lands adjacent to the town that will be cultivated to sugar beets.

We have in this county at the present time probably 150,000 acres of land, all of which is suitable for beet culture and at present is in cultivation and under irrigation. We have a natural water supply sufficient to irrigate more than this amount of land. The reservoirs which are now in process of construction will irrigate at least 100,000 more acres.

Our soil is a sandy loam, and our climate, having a great degree of sunshine during the crop season and an abundance of water for irrigation, gives us the ideal country for the production of sugar through sugar-beet raising; and the experiments that we have made show an average of from 18 to 23 per cent of saccharine matter, which percentage is greater than the average in the best fields in the State of Colorado. There is no reason why this industry should not be successful here.

Yours, truly, W. S. METZ.

Nature has done a great deal toward preparing the State for the sugar industry. Investigation reveals great mines of cheap coal, deposits of fuel oil, and natural gas. As in Utah and Colorado, along its streams exist conditions for natural water power.

SOUTH DAKOTA.

At Belle Fourche, S. Dak., the Reclamation Service is installing an irrigating project. Sugar beets have been the favored crop under consideration for utilizing the lands reclaimed. During the past season they were grown in this district experimentally. I publish a report made with reference to this point, giving results of experimentation with beets by the engineer in charge of the irrigation reclamation work:

BELLE FOURCHE, S. DAK., *December 28, 1906.*

DEAR SIR: It is probable that a beet-sugar factory will be built under this project in the near future, and several parties are figuring on the same at this time. Two of the parties furnished sugar-beet seed from Germany for planting for experiments last spring, and about 20 farmers in this vicinity grew beets from this seed, although I will say they were not given proper care and cultivation. If they had, the percentage of sugar would have reached a much higher mark. The stands were all first class, I think, none of the yields being less than 20 tons per acre, although such a small amount was grown by each one that it was hard to estimate the exact tonnage.

I send you herewith a sheet showing result of analyses of sugar beets grown, which may be of interest to you and which you may use if you desire.

Some effort is being made by the residents of Belle Fourche to secure a factory, but nothing definite has yet been done. As soon as the Belle Fourche project, which will reclaim 100,000 acres of land east of Belle Fourche, is completed, there is no doubt that two or three factories will be started in that area. Any further information you may desire I would be glad to furnish.

Very truly, yours,

R. F. WALTER, *Engineer in Charge.*

Analyses of sugar beets grown on or near the Belle Fourche project, one set of samples being sent on September 20 and the other October 20, 1906.

Grower.	Sugar contents of beets tested Sept. 20.	Sugar contents of beets tested Oct. 20.
	Per cent.	*Per cent.*
J. M. Eaton	11.95	17.1
L. J. Townsend	9.2	11.2
Chas. Shroyer	13.2	.....
B. Kemper	12.4	14.7
G. M. Fish	13.2	.....
C. Shipley	12.3	.....
Tom Eaton	11.3	.....
John McClure	12.1	16.1
J. W. Haines	12.1	16.8
H. C. Shreyer	11.4	.....
W. M. Matthews	12.6	.....
T. Brennan	12.6	.....
A. T. Adams	10.9	14.5
United States Reclamation Service	14.3	16.6
R. H. Evans	.....	12.7

OTHER STATES.

There has been more or less consideration given to building sugar factories in other States. A factory has been considered to some extent for Caledonia, N. Y. This point has grown beets for some time for the factory at Lyons. Its consideration at this time is due to the development work incident to this factory.

Parties owning a large body of land at Springer, N. Mex., have been considering the installation of a sugar factory to develop and utilize these lands.

During the past season considerable attention was given to the sugar industry in one or two places in Oklahoma and at Muscogee, Ind. T.; also at Sault Ste. Marie, Mich., and in a district in Cook County, central Oregon.

WORK OF THE BUREAU OF PLANT INDUSTRY.

B. T. GALLOWAY, CHIEF.

SCOPE OF THE WORK.

The studies and investigations which the Bureau is making in connection with sugar beets include the following: Studies of the effects of fertilizers, of cultural methods, of methods of siloing, and of the various diseases which attack sugar beets with a view to finding remedies and means of prevention; the production of single-germ beet seed; the breeding of strains that are alkali-resistant, of strains that mature early, and of strains that are adapted to dry farming; the development of methods for increasing the yield and improving the quality of the beets; the production and improvement of commercial sugar-beet seed, and the extension of the sugar-beet area.

SUGAR-BEET DISEASES.

The leaf-spot and curly-top diseases of the sugar beet proved fully as destructive during the past year as in 1905 or any previous year, and, as has been the case in the past, the leaf-spot disease was injurious only in the central and eastern portions of the country, while the curly-top disease was destructive in the West. Spraying experiments with Bordeaux mixture again proved successful in the control of the leaf-spot; and it was further discovered that the spraying need not be begun until the first spots appear on the leaves, which is generally the latter part of June or the first part of July.

A number of theories in connection with the curly-top disease have been investigated in an endeavor to ascertain its cause, but so far no positive results have been secured.

A number of other diseases, including root-rot and the damping-off disease, were investigated. These diseases for the most part, however, were limited to small areas. A study was also made to determine why seed beets sometimes fail to produce seed stalks. This work was only commenced last year, and as yet there are no results to report.

SINGLE-GERM SEED.

Very gratifying results were obtained in connection with the development of single-germ seed last season, marking a decided advance toward the desired end. Heretofore the highest percentage of single-germ seeds secured from selected plants was 26, which was in 1905, while, in 1904, 25 per cent was the highest from any one plant. During the past season one of the selected plants produced more than 50 per cent of single-germ seeds, two plants produced between 49 and 50, several others produced more than 40, while quite a number showed more than 30 per cent. In view of the fact that, when this work was first undertaken, the percentage of single-germ seed was only about 2, the ultimate success of the project seems to be assured.

EFFECT OF FERTILIZERS.

Experiments to determine the relative values of green crops, stable manure, and commercial fertilizers as applied to sugar beets were continued. Generally speaking, the best results have been obtained from these fertilizers in the order named. In connection with commercial fertilizers it has been found, as a rule, that phosphoric acid has a tendency to ripen beets prematurely, while nitrates delay the ripening period. These experiments will be continued the coming season.

SILOING SEED BEETS.

How to keep seed beets safely through the winter has for some time been perplexing the growers in some sections where seed production has otherwise been successful. In 1904 the outdoor silos proved to be better than sheds for storing the seed beets, while in 1905 many of the beets kept in such silos decayed, and most of those which remained sound did not produce seed. Experiments are in progress to determine the relation, if any, between the method used in keeping the beets and seed production; also to discover the best method of siloing to insure the preservation of the beets during the winter. The results of this work so far would indicate that long, narrow silos give better results than large silos and are better than sheds.

CULTURAL METHODS.

Except in a general way, in no part of the sugar-beet area is it definitely known what cultural methods will give the best results under different conditions of soil and climate. During the season of 1906, experiments were commenced along this line, but it will be necessary to continue this work for several seasons before definite

conclusions can be reached. The distance apart of the rows, the advantages of subsoiling, the time for plowing, and the time and method of preparing seed beds and cultivating the beets are the principal points under investigation.

SELECTION TO SECURE BEETS ADAPTED TO SPECIAL CONDITIONS.

The work of selecting for the purpose of obtaining strains of beets adapted to various conditions of soil and climate, which has been under way for two or three years, has been continued. The principal results sought for are as follows:

(*a*) Increased quality and yield of beets.

(*b*) Early-maturing strains, in order to increase the length of the harvesting season.

(*c*) Strains adapted to the semiarid regions.

(*d*) Strains resistant to alkali for planting in alkaline soils.

While it is yet too early to expect any definite results, the indications are that this work will ultimately be successful.

TESTING COMPARATIVE MERITS OF AMERICAN-GROWN AND FOREIGN-GROWN SUGAR-BEET SEED.

This work was commenced in 1902, and the fifth year of the work has just been completed. Comparative tests have been carried on in Michigan, New York, Colorado, Oregon, Utah, and Washington, partly in cooperation with the State experiment stations, to determine the relative merits of all varieties of seed grown by American seedsmen and seed growers and all imported varieties which are used by two or more factories in the United States.

During the past year this work was conducted by forty-nine experimenters throughout the sugar-beet area, under the direction of this Bureau. On the 278 acres planted, the American-grown seed yielded 14.32 tons of beets per acre with an average sugar content of 14.9 per cent, making a total of 4,267 pounds of sugar per acre, while the imported seed which is used by the various factories gave an average yield of 12.14 tons per acre with a sugar content of 15.1 per cent, making a total of 3,666 pounds of sugar per acre—a difference in favor of the American-grown seed of more than 600 pounds per acre. This, on the 376,000 acres harvested in the United States in 1906, would mean an increase in the total amount of sugar produced, without any additional cost, of about 226,000,000 pounds of sugar.

A publication will probably be issued in about a year's time showing the results of the foregoing experiments. The object of this bulletin will be to impress upon the sugar factories the great importance of securing the best seed obtainable; and this can be done

in graphic form by giving them accurate statistics as to the different percentages of sugar in different varieties and calling their attention to the fact that a difference of 1 per cent of sugar in the beet makes a difference of thousands of dollars in the proceeds from each factory at practically no increase in cost of manufacture.

BREEDING AND ESTABLISHING HIGH-GRADE PEDIGREE STRAINS OF SUGAR-BEET SEED.

The breeding of pedigree strains of seed from individually analyzed and recorded roots has been put on a firm basis in each of the five localities—New York, Utah, Washington, and two points in Michigan—where work is being conducted.

Twenty acres of seed beets, all of which analyzed 22 per cent or more of sugar, were grown on the farm of E. H. Morrison, at Fairfield, Wash., last summer. The seed secured from these beets, amounting to about 15,000 pounds, will be distributed this spring for testing in a commercial way in comparison with the seed used by the various factories throughout the United States.

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Issued November 30, 1907.

REPORT

OF THE

SECRETARY OF AGRICULTURE.

1907.

WASHINGTON:
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REPORT

OF THE

SECRETARY OF AGRICULTURE.

Mr. PRESIDENT:

I respectfully present my Eleventh Annual Report of the work of the Department of Agriculture for the past year.

It has been a year of untoward conditions requiring all the industry and skill of the farmers to grow an average crop. They have struggled not only with an erratic season but with a scarcity of help in all the States and Territories of the Union.

REVIEW OF PRODUCTION.

AVERAGE CROPS AND HIGHEST INCOME.

Such a year as 1907 has been, with its hard winter, summer weather in March, and late cold spring, gives exceptional emphasis to the wisdom of this Department's policy of diversifying farm products and of establishing new crops. A general crop failure in a field as large as the chief part of the Temperate Zone of a continent must be a rare occurrence.

No general crop failure afflicts the farmer this year, not even within small areas. The production of the farms, all things considered, is well up to the average of the previous five years in quantity, while its value to the farmer, as now appears at this annual day of reckoning, reaches a figure much above that of 1906, which by far exceeded any previous year's wealth production on farms.

Out of the farming operations of 1907, the railroads will get an average haul of freight, and foreign countries will take a heavy excess above home consumption. The farmer will have more to spend and more to invest than he ever before had out of his year's work.

DURUM WHEAT.

ITS INTRODUCTION.

When the Department of Agriculture brought durum wheat to this country from Russia and Africa during 1899 to 1902 the seed was sown that formed practically the entire foundation of the present crop of durum wheat. At a cost of $10,000 in the beginning, a crop worth $30,000,000 now grows in regions of low rainfall, where in the day of stock ranges the steer roamed on 20 acres to find his living. This crop has encroached on the home of the prairie dog and of the cactus. It has spread throughout a wide strip of country, extending from northern North Dakota to southeastern New Mexico and northwestern Texas. It is a common crop in Montana and Idaho and in parts of Washington, Oregon, and Utah.

INDUSTRIAL USES.

This variety of wheat has entered into home industries. To a considerable extent it is mixed with other wheat in making flour for bread. It is promoting the manufacture of macaroni and kindred paste products in this country and is prepared as a breakfast food. It is the grain through which the desert feeds the cities of the east at home and abroad.

LARGE EXPORTS.

As an export crop durum wheat has become prominent. In 1905 Europe took nearly 10,000,000 of the 20,000,000 bushels produced; in 1906 about 20,000,000 bushels of the crop of that year.

Last year two-thirds of the exports went to Mediterranean countries. The former sheep and cattle ranges sent macaroni material to Marseille, Naples, and Venice; to Greece, Spain, and the countries of western Europe; and even to the old homes of durum wheat—northern Africa and Russia. Shipments of this wheat were made to 43 ports in Europe and Africa named in trade reports of the collectors of customs, and to other ports unnamed.

VALUE IS OVER TWICE THE COST OF THE DEPARTMENT.

With an average production of about 15 bushels per acre, durum wheat this year covered an area of over 3,000,000 acres, many of them valueless for agricultural purposes before the advent of this new crop. Its value to the farmer is over twice the entire cost of the Department of Agriculture during the current fiscal year, including the Weather Bureau, the costly meat inspection, and the Forest Service.

BEET SUGAR.

RAPID INCREASE.

The beet-sugar industry in this country had not advanced beyond experiment nor given promise of prominence until about 1888. Since that year it has rapidly grown, under aid and encouragement from the Department of Agriculture and the experiment stations and with favorable legislation by Congress and several State legislatures.

About 560 short tons of beet sugar were made yearly from 1879 to 1887; in 1891 the quantity was 6,000 short tons; in 1892, 13,460 short tons; in 1893, 22,344 short tons; in 1897, 45,246 short tons; in 1899, 81,729 short tons; in 1901, 184,606 short tons; in 1903, 240,604 short tons; in 1906, 483,000 short tons; and in 1907, 500,000 short tons.

ECONOMIC VALUE.

As an acquisition to agriculture much may be said in favor of growing sugar beets for the factory. Tillage must be of the best and the soil fertile. The pulp of the beets, after the extraction of the sugar, is relished by live stock. The crop is grown under factory-contract conditions, and the farmer knows upon what he may depend for profit.

FACTORIES AND LAND VALUES.

Sugar factories occupy a belt across the continent in the sugar-beet zone and a belt from Washington to Arizona along the Pacific coast. From the easternmost factory in western New York they extend through Ohio, Michigan, Illinois, Wisconsin, Minnesota, Kansas, Nebraska, Montana, Colorado, Utah, and Idaho; and from eastern Washington through Oregon and California to southern California and Arizona.

In 16 States there were 64 factories in 1906, with a capacity of working 49,500 tons of beets daily. Factories with more than three-fifths of this capacity are situated in the Western Division of States, and in that region this new crop has so well established itself and the growing of sugar beets has proved to be so remunerative that sugar-beet farms of the medium sort increased in value $42.49 per acre from 1900 to 1905, as determined by special investigation by the Department of Agriculture, or from $99.47 per acre in 1900 to $141.96 in 1905.

VALUE OF PRODUCT AND CAPITAL.

To the fostering of this industry by Nation and States, to the instruction provided by the Department of Agriculture, by experiment stations, and by agricultural colleges, it has responded by

increasing the value of its production 543 per cent in nine years. The factory value of the refined sugar made in 1899 was $7,000,000, and in 1907, $45,000,000. More than $60,000,000 is now the value of the beet-sugar farms and factories.

One-third of the value of the beet sugar made this year would be enough to pay the cost of the Department of Agriculture during the current fiscal year and the National expense of the sixty experiment stations of contiguous United States when they shall have received the ultimate appropriation of the Adams Act.

ALFALFA.

IMPORTANCE AND VALUE.

Alfalfa, that extraordinary plant for producing wealth and doing wonders to farms, is occupying an important place in the plans of the Department of Agriculture, the experiment stations, and the agricultural colleges. Through their efforts largely it has rapidly gained success in cultivation throughout a vast area. The value of the crop as hay this year is supposed to be $100,000,000, and if the plans and efforts now under way to promote its extension receive a reasonable reward the value of the future crop will be several times the present amount.

MERITS OF THE PLANT.

This forage plant is a chemical laboratory in which nitrogen is taken from the air. It is a soil improver of the highest merit. As a flesh-forming feed for growing live stock, and as a milk and egg producer, it is unexcelled by any plant of large production.

It grows 2½ tons of hay to the acre as an average for the whole country where it is grown, or twice the average for all kinds of hay, and, besides this, is more nutritious than other hays.

EXTENSION.

The cultivation of alfalfa has been pressing eastward until now it has established itself as far as the longitude of eastern Kansas, except in southern Texas. It is established in some areas still farther to the eastward—in spots in Arkansas, in southern Wisconsin, northern Illinois, and northern Indiana, in the limestone regions of Kentucky and Tennessee, and in the southeastern corner of Michigan.

This plant is semi-established in Minnesota, Iowa, Missouri, and Ohio, and is making its way in Illinois and Indiana. Elsewhere the growing of this plant is mostly experimental, but with promise of success.

PRIZE WORTH HUNDREDS OF MILLIONS.

Further extension of alfalfa growing on large areas, by means of instruction by the Department of Agriculture, the experiment sta-

tions, and the agricultural colleges, is a prize that will be worth hundreds of millions of dollars yearly; and it will be won. What has already been secured aided in the rescue of the farm production of this year from the disasters of the weather.

IRRIGATION.

UNFAILING RELIANCE.

Among the large efforts that have the effect of giving steadiness to the agricultural production of the Nation at times of threatened adversity is irrigation. This is almost entirely confined to the arid and semiarid regions west of the one hundredth meridian and to the rice coast of the Gulf of Mexico in Texas and Louisiana, but will move eastward as its value is learned.

AREA.

The area now under irrigation is 11,000,000 acres, or a surface equal to the improved farm land of Georgia, or Virginia, or Michigan, or equal to one-third of the cotton area.

VALUE OF CROPS.

At the census average income per acre, with allowance for subsequent increase of price of products, the value of the crops raised on irrigated land this year would appear to be worth at least $175,000,000, an increase of 75 per cent over the value of 1899.

In 1908 an additional area of 5,000,000 acres will be under ditch and ready for settlement. When this additional area is settled, the total will be 16,000,000 acres. If the new area were at once productive, the irrigated crops of 1908, at the price of 1907, would be worth $250,000,000, or more, and would support a population of over 1,000,000 persons.

SUMMARY OF CROP INTRODUCTIONS AND EXTENSIONS.

The foregoing striking features of the results of crop introduction and extension within the last few years are some of the illustrations of the wisdom of the great movement of the Department of Agriculture, of the experiment stations, and of the agricultural colleges, to fortify and buttress the agriculture of the Nation against misfortune, and to give to it a sort of insurance by multiplying the sources of success. This policy has done much to keep the production of 1907 not only from disaster, but, all things considered, actually to keep it up to an average of recent years.

VALUE OF THE DEPARTMENT'S WORK.

CONCERNED WITH WEALTH PRODUCTION AND PRESERVATION.

It is difficult to express in dollars the value of the work of the Department of Agriculture to farmers, and therefore to the Nation,

but an attempt to do so was made last winter for the Committee of the House of Representatives on Expenditures in the Department of Agriculture, which made a total of $232,000,000.

Fundamentally the work of the Department is concerned with the production of wealth, as by increasing a crop yield per acre by plant breeding; and the preservation of wealth, as by suppressing insect and fungous pests; and with enabling farmers to make a fair sale of their products, as by promoting cooperative selling or by giving to the public information of the size of a crop in order that demand may be fairly adjusted to supply.

CHIEF CROPS.

CORN.

Four-fifths of the world's production of corn, as nearly as can be determined, grows in the United States, and in the world's international trade in corn this country contributes one-third to one-half of the exports, not including the products of corn-fed animals.

FACTOR IN NATIONAL PROSPERITY.—Corn is the chief of crops and exceeds every other prominent agricultural factor of national prosperity. It is a human food, and more especially a live-stock feed, with striking results. It is one of the great motive powers in the food of an energetic age. The starch of corn becomes the fat of the hog and the "finish" of the steer. No meat products are so much in demand in international trade as animal fats and oils. The value of these is more than one-half of the value of all exports of meat animals and packing-house products from this country. It is from four-fifths to nine-tenths of the value of these exports to Germany, to Italy, and to Norway and Sweden; and from two-thirds to four-fifths of these exports to France, and nine-tenths of these exports to Austria-Hungary, Denmark, and the Netherlands.

Fears of a failure or a large degree of failure of the corn crop this year diminished after midsummer and at last the harvest secured 2,553,732,000 bushels, a production that is almost exactly the average of the crops of the preceding five years. There have been three larger corn crops—those of 1899, 1905, and 1906.

ITS FABULOUS VALUE.—In value the corn crop of this year is much above the high-water mark of 1906. On the assumption that the crop will be sold by farmers at an average price not below the present one, its value is estimated to be $1,350,000,000, or 26 per cent above the average value of the previous five crops. Four crops before had exceeded one billion dollars in value.

The farm value of the corn crop of eight such years as 1907 would pay for duplicating every mile of steam railroads in the United

LIBRARY OF THE UNIVERSITY OF CALIFORNIA

States and pay for their costly terminals, rolling stock, and all property. In thirteen years it would replace the present banking power of this country in banking capital, surplus, deposits, and circulation, and in seventeen years it would replace the banking power of the world.

HAY.

Apparently the hay crop this year is more valuable than the cotton crop. On account of the varieties and qualities of hay its average price is difficult to determine without reports from crop correspondents. The computed value of the 61,420,000 tons of the crop is $660,000,000. The tonnage has been exceeded several times, but the value is $65,000,000 above the highest previous value, that of 1906. Compared with the average of the preceding five years, the quantity of the hay crop of this year is 2½ per cent higher and the value is 20 per cent higher.

COTTON.

If the cotton crop of this year does not eventually occupy second place in value instead of hay in the final estimates of the Department, if seed be included, it certainly has third place, even without seed.

The farm value of the 1907 crop of cotton and its seed is estimated to be from $650,000,000 to $675,000,000. The commercial expectations are that the crop will be found to be the third one in size ever raised, and perceptibly larger than the average crop of the previous five years. Its farm value is probably a little below that of last year's crop. Otherwise it will be the most valuable cotton crop ever raised in this country and 7 per cent above the average farm value of the crops of the previous five years.

SUFFICIENT FOR THE WORLD'S NEEDS.—The year was a trying one to cotton from planting time to nearly the end of the summer, but even under adverse conditions a crop has been produced that will be sufficient, with the surplus of last year, to meet the requirements of spinners until the next harvest.

The fears of a cotton famine that followed the low production of this country in 1901 have not been justified, and in the meantime efforts to make European spinners partly independent of the Upland cotton of the South by aiding the growing of "colonial" cotton have not made themselves felt.

Outside of the British East Indies, the production of cotton in the British colonies, possessions, and protectorates was 7,553 bales of 500 pounds gross weight in 1904 and 10,016 bales in 1905. In the French colonies, except French India and Indo-China, 400 bales were produced in 1904; in the German colonies, 1,500 bales in 1905.

LOW COST OF TRANSPORTATION.—Among the strong points of advantage possessed by this country's cotton is the low cost of transportation to market. Recent investigations by this Department indicate that the average cost of transporting cotton per 100 pounds from farm to local shipping point is about 16 cents; from local shipping point to seaport, about 40 cents; and from seaport to the United Kingdom, about 32 cents; the total being only 88 cents per 100 pounds, or less than a cent a pound.

WHEAT.

Wheat, the fourth crop of the year in value, is deficient in quantity by 5 per cent when compared with the average crop of the preceding five years. The 625,576,000 bushels produced will be enough for a large per capita consumption, with a remnant of many millions of bushels for export, although not as many as usual. During the last five years the wheat exports, including flour, have averaged 122,411,110 bushels, and during that period 18.6 per cent of the crops was exported.

Although wheat is 5 per cent in quantity below the average crop of five years preceding, it is 5½ per cent above the average value of these crops, or a little over $500,000,000. The crops of three years, 1901, 1902, and 1905, had a slightly higher value than this one.

OATS.

The only large crop to which a great degree of failure attaches this year is oats. Only 741,521,000 bushels were harvested and these were of low quality. In number of bushels this is the tenth oats crop ever grown in this country, and it is 19 per cent below the average crop of the previous five years.

In value the story is different. Contrasted with the loss of 19 per cent in quantity is a gain of 26 per cent in value in comparison with the five-year average; so that this year's crop is worth $360,000,000, or much more than the most valuable oats crop heretofore produced.

POTATOES.

The sixth crop in value is potatoes—292,427,000 bushels, worth $190,000,000. Three potato crops have exceeded this one in size—those of 1895, 1904, and 1906—but it is 2 per cent above the average of the previous five years. Its value is 26 per cent above the five-year average.

BARLEY.

Barley has pushed its way upward in production until it is now the seventh crop in value. The 147,192,000 bushels of this year are estimated to be worth $115,000,000. Only the crop of 1906 was larger, and the crop of 1907 is 2 per cent above the average of the

previous five years. The value of barley this year indicates an extraordinary situation, the price per bushel being about double what it was last year; hence the value of the crop is about 85 per cent above the average of the previous five years.

TOBACCO.

The tobacco crop has declined to 645,213,000 pounds this year and is smaller than the crops of many years. It is 11 per cent under the average of the preceding five years, yet the value is the highest ever reached, except in 1906, and is estimated to be $67,000,000, or 16 per cent above the five-year average.

SUGAR, MOLASSES, AND SIRUP.

As farm crops, sugar beets and sugar cane are valued herein as such, except that the cane products are taken into account if the cane is crushed on the farm. The large cane-sugar mill is classed with manufacturing instead of with agriculture; this is to preserve the census basis for comparison.

The farm value of the sugar beets in 1907 and of the sugar cane and sorghum cane and such molasses and sirup as were made on the farm is estimated to be $64,000,000. The sugar-beets value is slightly above the figure for 1906, and is 50 per cent above that for 1905, and twice the amount for either 1903 or 1904. The farm value of sugar cane, molasses, and sirup is estimated to be $33,500,000, which was exceeded only in 1904.

AS A MANUFACTURING INDUSTRY.—The popular interest in this subject is so large that it is worth mentioning as a manufacturing industry. The raw cane-sugar mill production of 1907 is estimated at 389,000 short tons, with a factory value of $28,000,000, the year 1904 alone exceeding this amount. The estimate for refined beet sugar is 500,000 short tons, worth $45,000,000.

Both kinds of sugar add to 889,000 short tons, worth $73,000,000. When mill molasses and sirup and sorghum and maple products and beet pulp are added, the total value of the ultimate products of the sugar, molasses, and sirup industry (the refining of cane sugar not included) in 1907 is $95,000,000.

FLAXSEED.

The 25,420,000 bushels of flaxseed of this year's crop are worth about $26,000,000, the quantity being 5 per cent under and the value 3 per cent over the average of the previous five years. The crop of 1902 is the only one that exceeded this one in value.

RYE.

With a production of 31,566,000 bushels, or 4 per cent above the average of the five previous years, the rye crop has a value of

$23,000,000, or 29 per cent above the five-year average. In three years, going back to 1891, the production has been greater, and the value has been higher in two years, 1867 and 1901.

RICE.

Rice is the twelfth crop in point of value this year and in both quantity and value is the record rice crop. The preliminary estimate is a production of 21,412,000 bushels of rough rice, or 963,540,000 pounds, an amount a little above the great crop of 1904 and 98 per cent above the average crop of the previous three years. This year's crop is worth $19,500,000 to the farmers, or 36 per cent above the three-year average.

The exports of domestic rice in the fiscal year following the crop year 1904 were 75,000,000 pounds of cleaned rice, 4,000,000 pounds in 1906, and 2,443,000 pounds in 1907. The imports of rice, less the foreign and domestic exports, were about 64,000,000 pounds yearly from 1900 to 1903, and about 62,000,000 pounds in 1904. After the crop of 1904 the tide turned and in 1905 there were net exports amounting to 41,000,000 pounds, followed the next year by net imports of 43,000,000 pounds, and in 1907 of 61,000,000 pounds. The only year before 1907 when the production was greater than the consumption was 1904, and the production in 1907 is greater than in that year. The Department of Agriculture has been helping the rice grower to get better varieties from the Orient, which will change imports into exports.

BUCKWHEAT.

Buckwheat was a crop of larger production before 1860 than it has been in subsequent years, but it has revived during the last half dozen years. The production in 1907 is 13,911,000 bushels, or 4.7 per cent below the average of the previous five years, and its value is $10,000,000, or 14 per cent above the five-year average.

HOPS.

The hop crop has lapsed somewhat from its position in 1905 and 1906. The production of 1907 is estimated at 48,330,000 pounds, or 4.6 per cent below the five-year average, while the value of the 1907 crop is placed at a little less than $5,000,000, or 29 per cent below the five-year average.

TOTAL OF CEREALS.

Upon consolidating the seven cereal crops and comparing the production of 1907 with the average of the preceding five years, a loss of 214,000,000 bushels is observed, or 5 per cent. That is, the average of the five years was 4,349,000,000 bushels, and the production in 1907 was 4,135,000,000 bushels. The oats crop was 175,000,000 bushels under

the average, and wheat 32,000,000 bushels, while rice was 11,000,000 bushels above, and rye and barley a little above.

Regarding corn as at the average of production and excepting oats, the other cereals show a net reduction below the five-year average of only 18,000,000 bushels, and this in a total production, omitting oats, of 3,393,000,000 bushels, so that the percentage of the net reduction is only one-half of 1 per cent.

In total value the seven cereal crops make a new high record that is above that of 1906 by $296,000,000. The farm value of the cereals of this year is estimated to be $2,378,000,000, or 23 per cent above the average of the previous five years.

SUMMARY OF CROPS.

In the production of crops the year 1907 has been a good one to all of the people as well as to the farmers. It has averaged with the previous five years after a general balancing of gains and losses. A great fall in oats below the average and much smaller declines in wheat, tobacco, hops, flaxseed, and buckwheat have been counterbalanced, and more than that, by increases above the average in cotton, hay, barley, rye, rice, and potatoes. This means material commodities and not the value placed upon them.

No such high aggregate of crop values has ever before been reached by farmers as for the crops of 1907. In estimating these, little if any use is made of the high prices before the break in the latter part of October. The present indication is that every crop except hops will considerably, if not very much, exceed in value the average of the previous five years. Extremely large rates of gain are observed for corn, oats, barley, rye, hay, tobacco, potatoes, rice, and cotton seed, and the rates of gain would be notable in any ordinary year in the case of wheat, cotton lint, and buckwheat.

In the grand total income from his crops of this year the farmer finds himself in better financial condition than before. He reckons his income in ten figures and he is still improving his farm, buying bonds, lending to his neighbors, and putting his money into the vaults of banks.

TOTAL WEALTH PRODUCTION.

HIGHEST RECORD.

Wealth production on farms in 1907, as expressed in value, transcended the high record of 1906, which was itself much above the highest amount before reached. In arriving at the total the farm products of the year are estimated in value for every detail presented by the census and at that point in production at which they acquire commercial value.

The grand total for 1907 is $7,412,000,000. This is $657,000,000 above the value of 1906, $1,103,000,000 above that of 1905, $1,253,000,000 above that of 1904, $1,495,000,000 above that of 1903, and $2,695,000,000 above the census amount for 1899.

The value of the farm products of 1907 was 10 per cent greater than that of 1906, 17 per cent over 1905, 20 per cent over 1904, 25 per cent over 1903, and 57 per cent over 1899.

A simple series of index numbers shows the progressive movement of wealth production by the farmer. The value of the products in 1899 being taken at 100, the value for 1903 stands at 125, for 1904 at 131, for 1905 at 134, for 1906 at 143, and for 1907 at 157.

During the last nine years wealth estimated as above explained was created on farms to the fabulous amount of $53,000,000,000.

SEVERAL GROUPS OF PRODUCTS.

Besides the crops, there were farm dairy products in 1907 which nearly reached $800,000,000. The price of butter increased 4¾ cents a pound over 1906 and of milk three-fourths of a cent a gallon.

More than $600,000,000 must be regarded as the value of the poultry and eggs produced on farms in 1907. The amount may easily have been larger. This industry has advanced at such a rapid rate that no arithmetic can keep up with it. The farm price of eggs in 1899 was 11.15 cents per dozen as an average for the United States; in 1903, 12.37 cents; in 1904, 17.2 cents; in 1905, 18.7 cents; in 1906, 17 cents, and in 1907, 18.2 cents.

Dressed poultry in New York sold for 10.78 cents per pound wholesale in 1899, for 12.97 cents in 1903, for 12.57 cents in 1904, for 13.36 cents in 1905, for 13.2 cents in 1906, and for 14.9 cents in 1907.

The animals sold from farms and slaughtered on them in 1907 were worth about $1,270,000,000.

DAIRY, POULTRY, AND LIVE-STOCK COMPARISONS.

Dairy products are much more valuable than any crop except corn, and are equal to one-third of the value of all cereals.

The poultry products are worth more than the wheat and perhaps as much as the hay.

The live stock sold from farms and slaughtered on them is worth nearly twice as much as the cotton crop.

It is only by comparison that a glimmer of understanding can be given to such numbers as the foregoing. Enough is apparent, however, to make it plain that the farmer of the United States is in a business that counts for National welfare by providing the wherewithal on a scale of magnificence that defies the imagination to comprehend.

FOREIGN TRADE.

EXPORTS.

Food and fiber were provided in such enormous quantities in 1906 that a great National surplus went abroad to feed and clothe many millions in foreign countries. High prices helped to swell these exports as expressed in money, and for the first time in the history of the world a country exported agricultural commodities of home production to a value greater than $1,000,000,000.

In the year ending June 30, 1907, the domestic exports of farm products were valued at $1,055,000,000, or $79,000,000 above the high record of the previous year. Four-fifths of these were plant products, and chief among these was cotton, with a port value of $482,000,000, an amount much above the highest value of any former year.

The exported grain and grain products were valued at $184,000,000, the unmanufactured tobacco at $33,000,000, the oil cake and oil-cake meal at $26,000,000, the vegetable oils at $20,000,000, and the fruits at $17,000,000. All were gains over 1906, except the item of grain and grain products.

Animals and animal products were exported to the value of $255,000,000, mostly composed of packing-house products, worth $203,000,000, or only $4,000,000 under the high-water mark of 1906. Exported live animals were valued at $41,000,000 and dairy products at $6,600,000.

EXPORT MOVEMENT MOSTLY SUSTAINED BY THE FARM.—The farm sustains most of the great export movement. If to the products that are fully agricultural are added those that are considerably so in combination with materials of other origin, and then are added the forest products and the commodities considerably composed of them, the remnant of the exports is but 28½ per cent of the total value of the record for 1907.

Cotton and its products are 29½ per cent of the total value of all exports; animals and animal products, 17 per cent; grain and grain products, 10½ per cent; all other exports sustained by agriculture, 6½ per cent; and the exports sustained by the forests are 8 per cent. Farm and forest together sustained 71½ per cent of the exports of 1907.

IMPORTS.

Agricultural products valued at $627,000,000 were imported in the fiscal year 1907, of which the plant products were $403,000,000, chief among these being sugar and molasses, valued at $94,000,000; coffee, $78,000,000; vegetable fibers, $62,000,000; fruits and tobacco, each valued at $26,000,000, and vegetable oils, with a value of $15,000,000.

Animals and their products were imported to the value of $224,000,000, with packing-house products, mostly hides and skins, valued at $96,000,000; silk valued at $71,000,000, wool at $42,000,000, and dairy products at $6,000,000.

FOREST PRODUCTS.

Never before 1907 were the year's exports of forest products so valuable as in this year. With an increase of $16,000,000 over 1906, the total of these exports ran up to $93,000,000, of which $52,000,000 was the value of lumber, $22,000,000 naval stores, and $18,000,000 timber.

On the other hand, the imported forest products were valued at $123,000,000, mostly composed of india rubber, valued at $59,000,000; lumber, valued at $21,000,000; gums, not including rubber, valued at $15,000,000; wood pulp at $6,000,000; and unsawed cabinet woods at $5,000,000. The total imports of forest products were valued at $26,000,000 above the total of 1906, which was the highest amount hitherto reached.

BALANCE OF TRADE.

The farmer is concerned in the Nation's balance of international trade, inasmuch as he provides the great bulk of the foreign credit which other classes of persons draw upon in the contrary movement of credit against this country.

The balance of trade in farm products in favor of this country in 1907 was $444,000,000, an amount that has been exceeded in only four years—1898, 1899, 1901, and 1902. In all other products the trade of 1907 produced a balance of only $2,500,000 in favor of this country.

MOST OF THE FOREIGN CREDIT PROVIDED BY FARMERS.—In eighteen years beginning with 1890 the farmers have not failed to secure a balance of at least $193,000,000, the low amount of 1895. The great aggregate of the 18 balances in the trade in farm products is $6,500,000,000, while the trade in other commodities during the eighteen years resulted in a grand adverse balance of $456,000,000.

A great stream of wealth has constantly been sent from farms to foreign countries to offset the adverse balance of trade in commodities other than agricultural; to pay the ocean freight costs on imports conveyed in foreign-owned ships; and to pay the interest, dividends, and principal on investments in the United States by foreigners. It is the farmer who has sent credit to expatriated Americans; it is he who has provided the immigrant with millions to send every year to the loved ones in the old countries; and, if there is still any credit to dispose of, the farmer has provided the American traveler in foreign countries with his pocket money.

THE FARMER'S THANKSGIVING.

The farmer has received much for which to be thankful. During the first half of the year he was threatened with general crop failure throughout the length and breadth of the country east of the Rocky Mountains. The very last day was exhausted that could be withheld from crop growth and still leave an average harvest.

Every necessary day for the development of the corn crop was worth 20,000,000 bushels of corn. Cotton needed a longer time and offered to pay 30,000,000 pounds of lint for the favor of each day of growth during the full term. Wheat offered over 6,000,000 bushels a day, tobacco 7,000,000 pounds, potatoes 3,000,000 bushels, and beets 6,000,000 pounds of sugar.

The entire wealth production of the farms was at stake and was dependent on a crop-growing season of sufficient length, and every one of its days was worth $50,000,000 to the farmer and to the Nation.

At the end of the harvest the farmer has provided the country with commodities that are equal to the average of recent years in quantity and vastly more than are needed for National consumption. His labor and his knowledge have been rewarded with products the sum of whose value is $7,412,000,000.

The miner can not restore the mineral to the mine. With the farmer it is different. The primal forces and atoms of the universe are his. The sun shines and the rain falls and the farmer applies his art and science to inexhaustible resources, ever adding enormously to the country's wealth, capital, credit, and welfare.

WEATHER BUREAU.

The creation of a research observatory at Mount Weather, Va., and the gathering together of a highly trained staff of men for the study of meteorological problems marks an important epoch in the development of meteorological science in this country. One of the first results achieved by that staff was the sending of meteorological instruments, by means of aeroplanes, to a greater altitude than has hitherto been accomplished. On October 3, 1907, the world's record for high flights was exceeded. On that day eight kites, in tandem, carried the meteorograph to an altitude of 23,111 feet above sea level. Daily observations of upper-air conditions have been continued for over three months in succession, practically without interruption, and it is probable that this record will be maintained indefinitely in the future. The observations obtained in this manner are placed before the forecast official in Washington each night. The latter is thus informed of the vertical gradients of temperature and the direction of the wind for altitudes varying on the average from one-half mile to 2 miles.

These facts are of great importance in the making of forecasts for the Middle Atlantic and New England States and for the elucidation of many problems of the upper air that hitherto it has been impossible to study.

WEATHER FORECASTS.

In the past forecasts of the weather, as is well known, have been based entirely upon the existing horizontal gradients of pressure and temperature at the surface of the earth. The formation of charts showing the distribution of temperature with increase of elevation above the earth's surface, which is now for the first time possible in our weather service, so graphically tells the story of the rise and fall of the thermal levels that the layman is able to comprehend their significance. It is apparent that when a comparatively deep stratum of abnormally warm or abnormally cold air persistently overlies a region the action of a moving cyclone or anticyclone on the weather experienced at the bottom of the atmosphere will be materially different from that which would be experienced were the upper air at a normal temperature.

The significance of these data from the view point of the forecaster is not yet fully understood, but certainly they present a fund of information that will be studied with profit by those whose duty it is to add to our limited knowledge of the science that must precede the art of weather forecasting.

The upper-air work at Mount Weather is thus described in detail because it is the one line of inquiry that at present holds out the greatest promise of immediate utility. The results already secured are deemed to be of such value that it is hoped means will be provided for the diligent prosecution of other lines of research work.

DESTRUCTION OF THE ADMINISTRATION BUILDING.

On the morning of October 23, 1907, the interior of the administration building at Mount Weather was discovered to be in flames. The fire spread so rapidly that the eight persons sleeping in the building that night barely escaped with their lives, two being seriously injured. It has been impossible to determine the origin of the fire. This building was used as an ordinary observing station such as is maintained at all of the various meteorological offices of the Bureau. It also contained the administrative offices and the kitchen, dining, sleeping, and general living rooms of the scientific staff.

When the structure is rebuilt it should be made entirely of fireproof material.

THE FORECAST SERVICE.

The forecasting service of the Weather Bureau continues to furnish useful information concerning the approach of untoward weather

conditions, the occurrence of damaging floods in the rivers, and of severe storms on the Great Lakes and the seacoast. Within the last year or so the river and flood service has been strengthened in its weak spots and somewhat enlarged by bringing into the system rivers which previously had no service. As now constituted it embraces practically all of the great navigable rivers of the country and many others. In view of the general desire for the improvement of navigation on the larger rivers and the development of the resources of the country tributary thereto, a strong river service becomes more important than ever.

SEISMIC DISTURBANCES.

The seismic disturbances which have occurred since the San Francisco disaster have fully aroused the scientific world to the importance of systematically studying these natural phenomena.

Exact knowledge of the character and magnitude of the motion of the ground when subjected to earthquake action is of vital importance to those whose business it is to design and erect the high structures now so numerous in all of our great cities. Earthquake-proof construction must be required, especially in great structures, even in regions which may seem to be immune; for probably it is only a question of time when some readjustment of the earth's strata under long accumulating stresses may occur in seemingly the most stable regions and an earthquake of greater or less severity be precipitated thereby.

Already action has been taken looking to the systematic study of earthquake phenomena by the formation of a National Bureau of Seismology in Strasburg, Germany. This organization is international in character.

It is submitted that this important work, since it affects the welfare of all the people, should be encouraged by the National Government, and that the Weather Bureau should be authorized to inaugurate and maintain systematic seismological observations within the United States and its Territories.

THE SALTON SEA.

The drying up of the Salton Sea, which now occupies a depression in the desert region of southern California, affords an opportunity of determining experimentally the rate of evaporation in the arid regions of the Southwest. In ten or fifteen years the sea will have disappeared, and in a somewhat shorter period its waters will have become so saline that its rate of evaporation will no longer be normal or representative.

RAINFALL AND EVAPORATION.

The two great factors which determine the amount of water available for purposes of irrigation are rainfall and evaporation. The

Weather Bureau collects data of rainfall for all parts of the country, but nothing is being done on the evaporation side of the problem. The demand for accurate information respecting the rate of evaporation is most pressing from hydraulic engineers who are called upon to draw plans for the construction of water-storage reservoirs in the various parts of the country and under widely varying climatic conditions. In addition to the needs of the engineer, a knowledge of evaporation in different climates is recognized as an important factor in the economy of plant life. The agriculturist should have the advantage of the most accurate information obtainable as to the loss of water from the soil by this process.

Reservoirs already constructed by private persons have largely failed of their purpose by reason of a lack of knowledge of the amount of evaporation. The great irrigation projects now under way in the semiarid regions and those which may be planned in the future will be greatly benefited by the knowledge which is here sought.

The Weather Bureau, in cooperation with the United States Reclamation Service and the United States Geological Survey, should enter upon a research looking to a solution of the problem.

FOREIGN METEOROLOGISTS STUDY AMERICAN WEATHER SERVICE.

It is probable that no other branch of science is as much indebted to the researches of citizens of the United States as is meteorology, Redfield and Espy, early in the nineteenth century, having been the first to collect the data, plot it, and exhibit to the world the cyclonic action of storms. Utilizing the knowledge thus made known and the further researches of the scientists of other nations, the United States has taken the lead in the practical application of meteorological science, our broad continental area and thorough electrical communication rendering it possible to bring an extensive system under one administrative head. The service is the result of an evolution, it being necessary to adopt new methods with each advancing step and to devise and invent appliances for the putting into effect of ideas that were unique. It has also required the application of discipline of military exactness in order to coordinate into an efficiently working machine 200 full meteorological offices with more than 900 auxiliary stations, and to produce an efficiently working unit that shall twice daily gather meteorological data from such a large area, collate and print it at many commercial centers, and, through the agencies of the press, the telegraph, the telephone, and the rural free delivery, place the deductions from the data before those who can make the most use of them.

Within recent years many scientific representatives of foreign governments have honored us by visits and by a study of the methods employed by the United States in the administration of its Weather Bureau.

BUREAU OF ANIMAL INDUSTRY.

THE MEAT INSPECTION.

The Federal meat inspection has been greatly extended and improved under the new law of June 30, 1906, and is now on a higher plane than ever before. Public confidence, which was unsettled by the agitation of the previous year, has been restored. The important matters of sanitation of slaughtering and packing establishments, preparation of meats and products, use of chemicals, preservatives, etc., and prevention of fraudulent labeling are now controlled and regulated, whereas formerly the Department had no authority over them, but was practically confined to an inspection before and at the time of slaughter to determine the health of the animals. The interstate transportation of meats and meat food products is also now under control.

Naturally a very marked increase has occurred in this branch of the work, as compared with the preceding year. Inspection was conducted at 708 establishments in 186 cities and towns during the fiscal year 1907, whereas in 1906 the corresponding totals were 163 establishments and 58 cities and towns. The number of employees engaged on meat inspection July 1, 1906, was 981; on July 1, 1907, this force had been increased to 2,290.

The meat inspection covered 50,999,034 animals, practically all of which were inspected both before and after slaughter. Of these, 149,792 carcasses and 529,876 parts were condemned for disease or other cause. The cost of this inspection was $2,159,474.12. While, therefore, all of the $3,000,000 appropriated by Congress for this purpose was not expended, it should be borne in mind that the law was in full force but nine months of the fiscal year, and that the service was constantly expanding during the year. The rate of expenditure during the first half of the period was considerably below the normal requirements under the new law. By using in the marking of meats a metal stamp with special ink prepared by the Department, instead of the label formerly employed, a saving estimated at half a million dollars a year is being effected.

In addition to the veterinary inspection there is a subsequent inspection of the meats and products, consisting of an examination by experts in the curing of meats and a laboratory inspection to determine the bacteriological and chemical condition of the finished products. For carrying on this work laboratories have been established at New York, Chicago, East St. Louis, Kansas City, Omaha, and San Francisco. As a result of this inspection more than one hundred different varieties of products which had been in circulation prior to the new act were found to be in conflict with it. Since then, however, the examinations show that as a general rule the packing

houses have been complying with the law in regard to preservatives and coloring matter, and also in regard to proper labeling.

The microscopic inspection for trichinæ, which has heretofore been applied to pork intended for export to countries requiring such inspection, has been discontinued. The experience of this country as well as of Germany has shown that under practical conditions a reliable inspection for trichinæ is not possible, as it is sometimes necessary to examine a carcass microscopically as many as twenty or thirty times before the parasites are found. Germany, while requiring our certificates of microscopic inspection, was not willing to accept them as conclusive, but reinspected all pork imported from the United States. As the inspection seemed to be of little or no benefit, but of considerable expense, it was stopped. The microscopic inspection for trichinæ has never been carried on or considered necessary for the protection of the American public, as thorough cooking or thorough curing kills the parasites, and it is not the custom of Americans to eat pork in a raw, uncured state.

As it is often difficult to determine just where to draw the line between what should be passed and what condemned in meat inspection, especially where carcasses are affected in some degree with tuberculosis, a commission of experts outside of the Department was appointed to consider and advise with regard to those portions of the Department's meat-inspection regulations relating to the disposal of carcasses affected with various diseases and abnormal conditions. This commission consisted of Dr. William H. Welch, professor of pathology, Johns Hopkins University, chairman; Dr. L. Hektoen, professor of pathology, University of Chicago; Dr. M. J. Rosenau, director of the hygienic laboratory, United States Public Health and Marine-Hospital Service; Dr. Joseph Hughes, president of the Chicago Veterinary College; Dr. V. A. Moore, professor of comparative pathology, Cornell University; Dr. Leonard Pearson, dean of the veterinary department of the University of Pennsylvania, and Dr. Charles Wardell Stiles, chief of the division of zoology, hygienic laboratory, United States Public Health and Marine-Hospital Service, secretary.

The report of the commission has been received and is being considered in the preparation of revised regulations. The general conclusion with regard to the portion of the regulations under consideration was that "if there be any general error in the regulation this is in favor of the public rather than in favor of the butchers and packers."

While the Federal inspection insures the wholesomeness of the product of establishments doing an interstate and export business, the Federal power can not reach the numerous small, local establishments whose product is sold entirely within a State. Some of the worst conditions have been found at places of the latter kind, and the

tendency of a strict inspection is to cause diseased and unfit animals to be sent to slaughterhouses having no inspection. If the public is to be fully protected, the Federal inspection must be supplemented by State and municipal inspection. An inspection such as is carried on in some places—consisting merely of an examination of meat as offered for sale in the market and the condemnation of any that may be tainted or spoiled—is not sufficient. The purchaser can usually detect spoiled meat. What is more important is a careful veterinary inspection of all carcasses at the time of slaughter, to exclude those which are diseased. There is great need for the States and municipalities to apply such an inspection at all places not under Federal supervision. In the meantime the Federal inspection label offers to the consumer a guaranty that the meat bearing it comes from healthy animals and has been prepared under sanitary conditions.

INSPECTION OF EXPORT ANIMALS.

The inspection of the Bureau of Animal Industry also extends to the export trade in live stock. Animals to the number of 536,291 were inspected for export, and 484,254 were again inspected on arrival at British ports by Bureau inspectors stationed there. Seven hundred and forty-one inspections were made before clearance of vessels carrying export animals, and they were required to conform to certain regulations as to space, fittings, attendants, feed, water, ventilation, etc. The losses of animals in transit were only about one-quarter of 1 per cent.

ERADICATION OF THE CATTLE TICK.

The progress made in the eradication of the cattle tick which transmits Texas fever demonstrates that the ultimate extermination of this costly pest is entirely practicable, if Congress and the State legislatures will provide the necessary means. The great benefit which will accrue to the cattle industry of the South, and incidentally to the country at large, from the success of this work will abundantly justify the necessary expense.

The work of tick eradication was not actively begun until July 1, 1906; yet as a result of work done to October 31, 1907, there have been, or will in the near future be, released from quarantine certain areas in Virginia, North Carolina, Georgia, Tennessee, Arkansas, Oklahoma, Texas, and California, amounting to approximately 60,000 square miles, and good headway has been made in still other areas. The work has been pursued in cooperation with State authorities in the States above named and in South Carolina, Alabama, and Louisiana. Complete returns to October 31 last show that during the first ten months of the present calendar year this work has included 2,307,934 inspections and 775,795 disinfections of cattle. Various approved methods for the eradication of ticks have been

used, including pasture rotation and dipping, spraying, and hand-dressing with oil and oil emulsion.

CONTROL OF CONTAGIOUS DISEASES.

The number of cattle moved from the area quarantined for Texas fever to northern markets during the quarantine season of 1906 was 1,000,629, shipped in 36,213 cars. These cattle were all for immediate slaughter and were handled under the supervision and regulations of the Department. There were also inspected in the provisionally quarantined areas of Texas and Oklahoma 126,238 head of cattle, which were permitted to be moved north for purposes other than immediate slaughter. Supervision was exercised over 137,902 dippings in crude petroleum and over the cleaning and disinfection of 36,895 cars.

The prevalence of sheep scab has been considerably reduced, and since the close of the fiscal year the quarantine for this disease has been removed from Wyoming and Idaho, and it is expected that later it may be removed from Utah. Such headway has been made as to give hope that, with another year's work, the disease may also be eradicated from Colorado, New Mexico, and Arizona. The total number of inspections of sheep for scabies was 62,625,831 (including 68,264 goats inspected for scabies at slaughtering centers), and the total number of dippings was 12,133,466, of which 2,640,408 were redippings.

The eradication of cattle mange or scabies is being continued, but has been retarded in some localities by the removal of fences from the public domain in conformity with an act of Congress, and by conditions on the open range where cattle travel great distances and mingle without restraint, making it easy for disease to spread and difficult to enforce proper sanitary measures. Under these circumstances it was found necessary to adopt more stringent regulations for the suppression of the disease, and better results are expected. During the fiscal year 1907 there were 15,243,323 inspections of cattle for scabies and 466,623 dippings. It would be of great advantage in combating contagious diseases of live stock if the public-land laws were so amended as to permit the leasing and fencing of the public domain so that owners might have better control over their animals and the promiscuous mingling of stock be largely prevented.

Although the troublesome venereal disease of horses known as maladie du coït or dourine, which prevailed in several of the Western States, was stamped out a year or more ago, owing to the insidious character of this disease it was thought best to continue inspection in the previously affected territory to make sure that no trace of the contagion remained. Nearly 15,000 inspections were made during

the fiscal year, and all suspected cases of which information was received were investigated, but without finding a single case of the disease. It therefore seems certain that as the result of diligent work for several years this disease has been completely eradicated and that there will be no recurrence of it unless the contagion is again introduced from abroad.

INSPECTION AND QUARANTINE OF IMPORTED ANIMALS.

A careful system of inspection and quarantine of imported animals is maintained in order to protect our domestic live stock from the contagion of destructive animal diseases which are found in other parts of the world. All animals offered for importation are required to be inspected, and certain kinds when coming from certain countries are required to be quarantined for a sufficient period to insure their freedom from contagion. Cattle are required to pass the tuberculin test for tuberculosis. During the fiscal year 147,897 imported animals were inspected, and of these 1,448 were quarantined. Blood tests are made of animals whose origin is such as to make it at all probable that they carry in their blood the causative agent of surra, a destructive disease which prevails in the Orient. In an importation of 51 cattle from India 17 were found to harbor this micro-organism and were destroyed. It is fortunate that the disease was detected and that the affected animals were slaughtered before the contagion could be introduced into this country. The absolute prohibition of the importation of all species of animals likely to harbor the parasite, from the sections where the disease exists, seems the only safe plan.

TUBERCULOSIS INVESTIGATIONS.

Tuberculosis has continued to be the subject of special investigations by the Bureau of Animal Industry. Further work has confirmed the view that the location of tuberculous lesions in the body is quite independent of the point at which the infectious material enters, and that the frequency with which tuberculosis occurs as a lung disease justifies the conclusion that the lung is not always infected directly through the air.

The work of the year also demonstrated that the commonest mode for the discharge of tubercle bacilli from the bodies of tuberculous cows is with their feces, that about 40 per cent of the tuberculous cows that show no outward symptoms are expelling and scattering tubercle bacilli, and that tubercle bacilli passed with the feces of tuberculous cows are actively pathogenic. When it is borne in mind how frequently milk contains cow feces, and that the percentage of dairy cows known to be tuberculous is considerable, the facts presented seem to warrant the conclusion that tuberculous cows are responsible

in a great measure for the prevalence of tuberculosis in the human family.

During the past year there has been considerable agitation in the District of Columbia with reference to the improvement of its milk supply. The Commissioners of the District appointed a committee or conference composed of scientists, physicians, veterinarians, milk producers and dealers, attorneys, and business men to consider methods for obtaining pure and wholesome milk and to advise as to proper legislation to that effect. In order to assist in this work, the Secretary of Agriculture, about April 1, directed the Bureau of Animal Industry to apply the tuberculin test to the herds of all dairymen who might request such action. In tests made by the Bureau and by the health department of the District of Columbia, covering 37 herds with 658 cattle, 18 per cent were found to be tuberculous. Some of the reacting animals had every appearance of being in good health, and several of this kind were removed to the Bureau Experiment Station, where it was found that they were discharging tubercle bacilli in great numbers and that their milk produced tuberculosis in guinea pigs.

The examination of sediment taken from the cream separators of public creameries throughout the country has demonstrated the presence of tubercle bacilli in about one-fourth of the samples. These creameries must be regarded as an important source of tubercular infection for the hogs and calves that are fed upon the separated milk that is returned to the farm from the creamery. State laws should be enacted requiring the sterilization of all milk and other products before they are returned by the creamery to the farmer for use as food for live stock.

The length of time that tubercle bacilli will live and retain their virulence in butter under usual market conditions is also being made a subject of investigation, but the work has not proceeded far enough to give definite results.

For the past five years careful and extensive scientific studies have been made of the comparative characters of human, bovine, and avian tubercle bacilli, and the results have been published.

The immunization of cattle against tuberculosis is being investigated.

HOG CHOLERA INVESTIGATIONS.

Continued experiments with hog cholera have again demonstrated that the contagion consists of a virus which exists in the blood and other fluids of diseased animals, but which can pass through the finest filter, is invisible under the microscope, and therefore can not be isolated or discerned by any of the usual methods.

The method of immunizing hogs against cholera, to which reference was made in last year's report, has been tested much more extensively, and the results show quite clearly that a comparatively certain method of protecting hogs from this disease has been secured. Hogs that have recovered from the disease or that have been exposed without contracting it are injected with suitable amounts of virulent blood from diseased hogs, and thus their immunity is heightened. The blood serum of these immunes is then used in vaccinating the hogs which it is desired to protect. The method giving the best results is to inject blood from diseased hogs simultaneously with the immune serum. By this method of vaccination hogs are protected for three and a half months or more, while by the use of the serum alone the protection can not be expected to last longer than three weeks. The immunized hogs probably retain for several months their power to furnish a potent serum. The serum probably can not be used successfully as a curative agent unless administered within four days after actual infection has taken place.

In order that this method may be more extensively tested, it is expected to make arrangements for the State experiment stations to test serum which will be furnished to them by the Department. It is hoped that the practicability of this method for combating hog cholera may thus be determined within a short time.

OTHER PATHOLOGICAL WORK.

Rabies continues to prevail in many parts of the country. When requested the Bureau examines suspected cases and makes diagnoses. During the year 47 post-mortem examinations were made in the pathological laboratory, and in 27 cases (all dogs except two—a sheep and a cat) the diagnosis was positive. Twelve of the positive cases were from the District of Columbia, 6 from Virginia, 5 from Maryland, and 1 each from Maine, Wisconsin, North Carolina, and South Carolina. In addition, several cases were investigated at the Bureau Experiment Station, and some of the animals which had been bitten were kept under observation and the disease studied as it developed in them.

A disease of the bobwhite, somewhat similar to grouse disease in Great Britain, appeared in several sections of the country, and as it seemed to threaten extensive destruction to this popular game bird an investigation into its cause and nature was promptly undertaken, and a preliminary report was published to assist in combating it.

The importation of cattle from India, before mentioned, some of which were found to carry in their blood the minute parasite which is the specific cause of the disease known as surra, afforded an opportunity for a study of that disease. Much was learned of its char-

acter and of the remarkable periodical development of the living parasites within the blood of the affected animals.

Among other lines of work in progress is an investigation of swamp fever in horses in cooperation with the Minnesota Experiment Station. The results so far indicate a probability of obtaining a satisfactory treatment for the disease.

WORK ON ANIMAL PARASITES AND PARASITIC DISEASES.

In the first series of field experiments in connection with a study of the life history of the roundworms of sheep, with the view of determining if possible methods of preventing infection, a system has been worked out by which lambs may be raised free from hookworms and stomach worms, and the length of time during which infection persists in pastures under certain climatic conditions has been determined. This information has been published.

An investigation of the distribution of the gid parasite of sheep in Montana shows that it is widely prevalent there. A comparison is also being made between specimens of gid parasites of American and European origin, in order to determine whether the two are of the same or different species.

An investigation is in progress concerning the so-called "palisade worm" disease of horses, which occasions the loss of a large number of animals annually in Wyoming and neighboring States.

SHEEP DIPS.

Cresol dips and coal-tar creosote dips to be used in the official dipping of sheep for scabies have been added to the two classes of dips previously sanctioned for this purpose, namely, the lime-and-sulphur and tobacco-and-sulphur dips. A large number of proprietary substances belonging to these four classes have been submitted for examination, and permission has been granted for the use in official dipping of those which were found to conform to the prescribed standard.

DISTRIBUTION OF BLACKLEG VACCINE, TUBERCULIN, AND MALLEIN.

The distribution of vaccine to prevent blackleg in cattle has been continued with good results, about 1,250,000 doses having been prepared and distributed to stock raisers during the fiscal year. This disease is becoming much less of a menace to young cattle than it was some years ago, when the mortality without vaccination amounted to over 10 per cent in certain sections. It is evident that the vaccine in a few years has not only saved many animals to the

breeder, but has gone far toward the eradication of blackleg from the pastures of the country.

Tuberculin and mallein, for the diagnosis of tuberculosis in cattle and glanders in horses, are furnished to official veterinarians and health officers. During the year 129,050 doses of tuberculin and 41,012 doses of mallein were prepared and sent out, more than half of the mallein being furnished to the War Department.

ANIMAL HUSBANDRY WORK.

Experimental work and investigations are being carried on by the Bureau of Animal Industry in connection with the breeding of horses, cattle, sheep, and poultry, besides some small animals, and in the feeding of hogs, cattle, and poultry, most of the work being in cooperation with State experiment stations.

HORSE BREEDING.

The work in the breeding of American carriage horses, in cooperation with the Colorado Experiment Station, is progressing satisfactorily. During the fiscal year 11 foals, the progeny of selected parents, were dropped—2 males and 9 females. No additional horses were purchased.

The work in breeding Morgan horses, which is being carried on in cooperation with the Vermont Experiment Station, has been greatly extended through the generosity of a public-spirited citizen of Vermont, who donated to the Department a farm of 400 acres near Middlebury, to be used in these operations. There were in the Vermont stud on July 1, 1907, 1 stallion, 9 brood mares, 1 two-year-old filly, 8 younger fillies, and 1 weanling colt.

SHEEP BREEDING.

There is great need of a breed of sheep suitable to the range conditions of the West, the requirements being for sheep that will yield a profitable clip of wool, produce good mutton lambs, and stand flocking in large numbers. It is believed possible to combine these characteristics in one breed, and with this idea in mind an experiment was begun in the fall of 1906 in cooperation with the Wyoming Experiment Station. Eighty-nine ewes and four rams have been purchased for foundation stock.

BREEDING MILKING SHORTHORNS.

Experiments in developing a milking strain of Shorthorn cattle have been begun in cooperation with the Minnesota Experiment Station and with nine Minnesota breeders, the latter having agreed to allow their herds to be used and to manage them according to instructions of the Department and the station.

BEEF PRODUCTION IN THE SOUTH.

Experiments in steer feeding under southern conditions have been conducted for the past three years in cooperation with the Alabama Experiment Station, and another experiment in the Tennessee valley (northern Alabama) is now in progress. The object of these experiments is to show what can be done under farming conditions in the way of improving the native cattle for beef purposes by means of proper feeds and the use of pure-bred bulls, and to make southern farmers familiar with the use of their by-products for meat production.

POULTRY BREEDING AND FEEDING.

The poultry investigations in cooperation with the Maine Experiment Station are being continued, the objects being to increase egg production and to compare the yields and welfare of hens when kept in flocks and inclosures of different sizes. From year to year the better laying hens are selected by their records in trap nests and mated with the sons of heavy layers. The results have shown that by the methods used hens with greater laying capacity can be obtained.

A poultry-feeding experiment was begun in the fall of 1906 at the Bureau quarantine station at Halethorp, Md., to determine the respective values of the moist mash, dry mash, and hopper methods of feeding. Further experiments will be conducted at the Bureau Experiment Station near Washington, D. C., which is a more favorable location and where a suitable equipment is now being built.

ANIMAL NUTRITION.

The experiments in animal nutrition with the respiration calorimeter, in cooperation with the Pennsylvania Experiment Station, during the fiscal year have consisted of a continuance of the investigations concerning the influence of age and individuality upon the metabolism of cattle, and eight additional experiments, together with a number of check tests to control the accuracy of the apparatus. A bulletin upon the energy value of red-clover hay has been prepared for publication.

At the beginning of the new fiscal year, July 1, 1907, the work in animal nutrition was materially enlarged by the addition of cooperative experiments in feeding beef cattle at the Missouri Experiment Station. A large number of steers are being fed to compare the results of feeding 2-year-olds and calves, and exhaustive investigations are planned in the feeding of steers from birth to maturity. Representatives of different lots and ages, with supplies of the feed used at the Missouri Experiment Station, will be sent to the Pennsylvania Experiment Station for tests in the respiration calorimeter.

CLASSIFICATION FOR AMERICAN CARRIAGE HORSES.

The Bureau of Animal Industry has been instrumental, by means of a cooperative arrangement with the American Association of Trotting Horse Breeders, in preparing a uniform classification for American carriage horses. The adoption of this classification at State fairs and similar gatherings is expected to aid materially in fixing a uniform type of horse and to enable the farmer to appreciate more the value of the horses raised by him and thus secure some of the large profits made by middlemen, who now buy cheaply from the farmers and after a few months of handling and finishing often sell at fancy prices.

WORK RELATING TO THE DAIRY INDUSTRY.

A large amount of work, both educational and research, has been accomplished in the Dairy Division of the Bureau of Animal Industry during the year.

SOUTHERN DAIRYING.

Considerable effort has been expended toward improving the dairy conditions of the South under a special appropriation made by Congress for this purpose. Nine men have been engaged in the work in seven States. The work has enlisted the attention and good will of the farmers. Assistance has been rendered in the remodeling of old barns and the building of new ones, the construction of silos, the selection and breeding of herds, and the keeping of records of feeds and of the products of the dairy herds. Local market conditions and the sources of the supplies that are brought into the South from outside territory have been investigated.

Many farmers have been induced to keep records of their herds, so as to show the cost of feed and the amount realized from the products both before and while carrying out the suggestions made for improved methods. Such records have been kept for 70 herds, comprising 1,606 cows. The results from 16 herds have been compiled for illustration and show an average increase of $3.75 in the monthly production of each cow. This is a striking example of the practical results to be obtained by the adoption of better dairy methods in the South.

The work has met with uniform favor. So encouraging have been the results of the Department's work that similar work is being taken up by some of the States. It is believed that after this special educational work has been well started the Department should withdraw and the States should continue it.

BUTTER INVESTIGATIONS.

Investigations to determine the cause of fishy flavor in butter are being continued and progress has been made, but a complete solution

has not yet been reached. This trouble is the cause of heavy loss to the trade.

Experiments have also been made concerning the amount of acidity in cream and its effect upon the keeping quality of butter. Several thousand pounds of butter were made from cream having various degrees of acidity and the butter was stored at different temperatures to test its keeping qualities. It was found that pasteurized cream, churned sweet without starter, produced remarkably fine butter that kept without deterioration for weeks after it was taken out of storage. This was at such marked variance with the general views of butter makers that it has been deemed best to repeat the experiments during the coming year. If the findings of the past year are confirmed, almost a complete revolution in the methods of making butter from sweet cream seems likely to occur.

During the year an extremely simple and rapid method of determining the amount of moisture in butter and other products—a great need of the butter makers—was worked out by the Dairy Division. Application for patent has been made in such a way that the apparatus and method may be used by any person in the United States without payment of royalty.

LABORATORIES AT ALBERT LEA, MINN.

In the spring of 1907 laboratories for butter and cheese investigations were established at Albert Lea, Minn., in cooperation with the Minnesota Experiment Station. Bacteriological and chemical laboratories have been built and equipped, and arrangements have been made for a large supply of milk to be used for experimental purposes.

CHEESE INVESTIGATIONS.

The cheese investigations consist of three general lines, namely, soft-cheese experiments in cooperation with the Storrs (Conn.) Experiment Station, Cheddar cheese investigations in cooperation with the Wisconsin Experiment Station, and Swiss cheese investigations at Albert Lea, Minn. The work on the Camembert type of cheese, which has been in progress for the last few years, has been practically completed, and a bulletin giving directions for making this kind of cheese was published during the year. At present a study is being made of the problems involved in the manufacture of Roquefort cheese. These experiments are intended to avoid the necessity of importing European cheese, as we have cheaper grasses and mill feeds than any other country.

IMPROVEMENT OF THE MILK SUPPLY.

Following the success of the milk and cream competitive exhibition in connection with the National Dairy Show at Chicago in 1906,

similar contests have been held in other cities and have had a marked effect in the improvement of the milk supply.

A feature of the year's work was the investigation of the milk supply of Washington, D. C. Nine hundred and sixteen dairies and dairy herds, with 16,446 cows, were inspected and rated in accordance with a score card prepared by the Dairy Division. With few exceptions the conditions found were very unsatisfactory, the average score being only 45 out of a possible 100. This result may be considered as giving some indication of the quality and condition of the milk supply of the country, as it is believed that the conditions around Washington are no worse than those existing around other large cities.

The Department is taking an important part in the general movement for a better milk supply, and assistance in that direction has been rendered to a number of cities. Insanitary conditions of milk production and the prevalence of tuberculosis in dairy herds are two evils that should be overcome. Dairy products, which form a large part of our food supply, need special attention in order to insure wholesomeness. Is it the desire of Congress to supplement existing legislation by giving the Department authority to inspect all dairy cows and dairy establishments whose products are to enter interstate or foreign commerce, so as to exclude products of diseased cows and products prepared under insanitary conditions, according to the principle on which the meat inspection is based?

CREAMERY INVESTIGATIONS.

The economic features of the creamery business have received special attention during the past year. Reports were solicited from creameries with a view to giving them assistance in their methods of conducting the business. At the close of the year from 500 to 600 creameries were reporting monthly. A careful analysis of these reports shows a heavy loss to many creameries and to the farmers supplying them, owing to lax methods and the absence of system in keeping records. These losses are computed to be not less than $5,000,000 a year for the entire country. Whenever reports indicating defective work are received, letters are written pointing out the defects and suggesting remedies.

The market inspection of butter at Chicago and New York has been continued with a view to assisting creameries to improve the quality of their product. Large quantities of butter deficient in quality are found in these markets. When requested by the shipper, the experts of the Dairy Division examine a shipment on its arrival at market and send to him promptly a reliable report as to its condition and quality. If the butter is not of good quality, they state what the defects are and make suggestions for overcoming the trouble. This work has resulted

in a general improvement in the quality of the butter received on the market and has thus enabled the creameries to obtain better prices.

OTHER DAIRY WORK.

Farmers and dairymen are being encouraged to keep records of their dairy herds. It is believed that if this practice were more generally adopted much pecuniary and other benefit would accrue to the owners of dairy cows.

The work of planning dairy buildings of various kinds has been continued. During the year 56 different plans have been drawn and 504 blueprints made and sent out.

A thorough and prolonged study of the problems connected with the secretion of milk has been undertaken in cooperation with the Missouri Experiment Station. Other work includes a study of pasteurization and other processes which may affect milk from a bacteriological and chemical standpoint.

The Dairy Division installed and conducted at the Jamestown Exposition what was termed a modern dairy plant, showing the equipment and methods for a small dairy farm and for a large city milk business. Literature was distributed and stereopticon lectures were given.

RENOVATED BUTTER INSPECTION.

The Dairy Division carries out the provisions of the law of 1902 respecting the inspection of renovated butter, also known as "process" butter. There was produced during the year 63,000,000 pounds of this product, at 49 factories. This production represents an increase of 15 per cent over the previous year.

BUREAU OF PLANT INDUSTRY.

The work of the Bureau of Plant Industry covers a wide field. The Bureau is striving to aid the farmer in protecting his crops from destructive diseases; it points out ways of improving crops by breeding and selection, as well as by better methods of tillage and better methods of management; it explores the world for new crops, and when these are found and introduced, it encourages and supports the efforts made in their production until new industries are established. The principal results secured during the year along these and other lines are briefly set forth under the following headings.

THE WORK OF THE PATHOLOGISTS.

During the year the pathologists of the Bureau have been called upon to undertake a number of new investigations and to continue important lines of work already under way.

ERADICATION OF PEAR BLIGHT.—It was pointed out in my last report how important work had been inaugurated on the Pacific coast with a view to preventing the destruction of the extensive pear orchards, valued at many millions of dollars. Pear blight has been and is devastating these orchards, and the Department, in cooperation with State authorities, has been working to check it. The systematic work undertaken in the matter of eradicating blight from the orchards through winter pruning has led to beneficial results. The progressive orchardists who have carried on the work thoroughly have succeeded in holding the disease in check and in securing a profitable crop of fruit from the treated orchards. In other cases, however, principally as the result of careless treatment or no treatment at all, many orchards have been destroyed. The work will be continued this coming season and every assistance possible given to those orchardists desirous of fighting the disease. As already indicated, the Department has had the hearty cooperation of the State experiment stations and other State authorities, who are fully alive to the importance and necessity of doing all within their power to aid the fruit growers of the respective States in which they are located.

CONTROL OF APPLE DISEASES.—Another line of work which has been carried on successfully during the past year has had for its object the control of apple diseases in the Ozark Mountain region. This section of the country is developing into a fine fruit region, and the value of the orchards is increasing yearly. Since the orchards have come into bearing, however, various serious diseases have appeared, and the vital question of how best to control these diseases has arisen. Some of the work started last year in Nebraska and localities in Missouri had to be discontinued on account of the destruction of the fruit by cold. In a considerable portion of the Ozark region, however, there was a good crop of fruit not injured by cold, and in these orchards the control of bitter rot, black rot, and the fruit blotch was again practically complete where the methods recommended by the Department were carried out, from 95 to 98 per cent being saved in the sprayed orchards. In all this work combination treatments have been made in order to prevent both diseases caused by fungi and injuries produced by insects. In this work the Bureau of Plant Industry is cooperating with the Bureau of Entomology.

PREVENTION OF FOLIAGE INJURY IN SPRAYING.—For a number of years it has been a problem with pathologists to find some successful way of treating the peach with fungicides in order not to injure the foliage. Some of the standard fungicides often cause complete defoliation. For this reason it has been found difficult to control a number of serious diseases affecting the peach by any of the ordinary treatments. This year it was discovered that a sulphur wash made

by combining lime and sulphur, with no other heat than that produced by the slaking of the lime, gave a preparation which was not injurious to peach foliage and which prevented the scab and reduced peach rot to 10 per cent on the sprayed trees, whereas unsprayed trees had 75 per cent of the disease. This fungicide, further, completely prevented the leaf-spot fungi and produced no injury whatever, either to foliage or fruit. While this preparation has been previously used in winter when the trees were dormant, this is the first time it has been tried on trees in active growth, with the success as indicated.

CONTROL OF CALIFORNIA PEACH BLIGHT.—Last year mention was made in this report of a very serious disease of the peach in California, popularly known there as "peach blight." Experiments were conducted during last fall and winter for the control of this disease, and, as the result of this work, it was found that the disease could be completely controlled by the use of standard Bordeaux mixture or lime and sulphur wash applied early in the fall, about the time of the first rains. The methods recommended by the Department were widely used in California the past season with complete success, and we have been reliably informed that the treatment has meant many millions of dollars to the peach industry of that State.

STUDY OF CROWN GALL DISEASES.—The pathologists in this Department and in some of the experiment stations have for a number of years had under investigation a disease of fruits commonly known as "crown gall." Heretofore no organism has been definitely proved to be the cause of this disease. The results of the Department's work the past season indicate that there are two types of the malady. One form, which occurs in apples, producing hard galls, appears to be noncontagious, while the other, the soft gall, which occurs occasionally on apples and is the common form on stone fruits, especially the peach and plum, is very contagious. Two of our pathologists working on a similar disease in another plant have isolated an organism which produces galls practically identical with the soft crown gall on the peach, plum, hop, and numerous other plants. This is an exceedingly important line of investigation and doubtless will pave the way for securing information which will be worth a great deal to the fruit interests of the country.

COOPERATIVE WORK ON FOREST DISEASES.—The great interest in all matters pertaining to the protection of our forests and forest trees has led to the further organization of work in the Bureau having for its object the special study of forest pathology. In order to carry out this work to the best advantage, cooperative arrangements have been made with the Forest Service to the end that the strictly pathological work is conducted by the Bureau of Plant Industry, while the practical application of laboratory discoveries is worked out and applied in the field by the forest experts.

NEW CROPS AND NEW INDUSTRIES.

The general policy of the Department, inaugurated several years ago, having for its object the development of home industries for the purpose of keeping money in the hands of our own people, has been followed during the year. Elsewhere in this report figures are given showing the immense amount of cash we still send abroad for things that we might grow at home. During the year experts of the Bureau of Plant Industry have been engaged in exploring foreign countries, securing new plants worthy of trial here.

ORIENTAL PLANT EXPLORATIONS.—China has proved a fruitful field for this work, and an explorer has been kept there constantly during the year. His work has taken him through the little-known regions of southern Siberia, the border of Manchuria, the excessively dry mountains west of Pekin, and through the fertile country between Pekin and Hankau. This explorer has sent to this country over a thousand living seed and plant specimens for trial. Among these are promising blackberries and currants from northern Korea; a north Manchurian apple; a collection of 24 named pears from north China; several bush cherries and plums and peaches from northern Siberia—perhaps the very northern limit of peach culture in the Orient; drought-resistant alfalfas; dry-land rices; staple foods of the native Manchurians, but unknown to us, from regions where the climate is similar to that of the Dakotas; and a cherry noted for remarkable earliness, ripening its fruit in mid-April in northern California. Besides these, the explorer has sent in a large number of ornamental plants which our nurserymen have been for some time anxious to secure, because of the unusual hardiness of these north China species.

NEW ALFALFAS AND CLOVERS.—During the year an explorer was sent out for the purpose of securing forage crops and was still abroad when my last report was submitted. He has returned with seeds of the yellow-flowered Siberian alfalfa, and these seeds have grown into promising plants in the severe climate of the Northwest. The results of their trial will determine whether we shall import large quantities of the seed, as we have previously done with the Turkestan and Arabian alfalfas, both of which continue in their respective territories to gain in popularity. The Toten clover, secured from Norway, where it is cultivated for its extreme hardiness, is being tested in the Dakotas.

Two of the most interesting and promising introductions of the year were secured through the cooperation of the American minister at Pekin. Forty years ago a French missionary found alfalfa growing in the drier parts of Mongolia. In connection with the life-history studies being conducted by the Bureau, information was secured regarding this plant, the facts indicating that alfalfa

was introduced into China about 120 B. C., and that it had been grown in the dry, cold regions of Mongolia ever since. Full information regarding this crop and one or two others was forwarded to our minister, and through his kindness small quantities of seed of alfalfa, a naked oat, and one or two other promising things were forwarded to us. The accounts sent by the missionaries who aided the minister make it seem very probable that the alfalfa is grown under dry-land conditions, and it is hoped the plant will prove a valuable addition to the collection of varieties now being studied in a scientific and practical way at various stations in the West.

NEW RICE VARIETIES.—For the rice growers of the South there have been introduced 46 varieties from different parts of the world, among them the One Hundred Day rices—early sorts, which, in Japan, give crops when ordinary rices fail.

DEVELOPMENT OF A MANGO INDUSTRY.—The fruit growers of our tropical possessions have had their interest in mango growing stimulated by the fruiting of some of our East Indian fine-flavored varieties. All the local nurserymen are ready to sell in quantity several of the introductions of the Department, and not only are the experiment stations of Hawaii and Porto Rico taking up this fruit, but, what is especially important, private plantation owners are planting out orchards of our introduced sorts.

BAMBOO INTRODUCTIONS.—The growing scarcity of wood for manufacturing purposes has led the Bureau to make some extensive investigations of bamboo culture in Japan and other countries. Already a number of varieties have been introduced and steps have just been taken for the inauguration of a considerable number of plantations of these important plants in different parts of the South.

ENCOURAGING THE PRODUCTION OF RAW MATTING MATERIAL.—Reference has been made in previous reports to the encouragement which is being given to the matting industry of this country. The Department is anxious that we grow the raw material for the manufacture of this important product, of which we import five or six million dollars' worth annually. Our explorers have succeeded in securing an abundance of young stock of Oriental and Egyptian matting plants, kinds which are essential to the success of the industry here. Plantations of these are being established in a number of portions of the South in cooperation with influential men who are in earnest in regard to making this industry a profitable one, if it is practicable to do so.

LIFE-HISTORY STUDIES OF PLANTS.

Closely allied with the extensive work of plant introduction are the studies of the life history of crops and crop plants. This work has nothing to do with the mere testing of varieties. Life-history

studies have for their object the securing of knowledge of the requirements and limiting factors of different varieties—knowledge which will tell us why one variety will succeed and why another may fail. The failure properly interpreted may give us an insight into the life history of the variety which will permit of its successful utilization under different conditions.

THE DATE PALM.—The plan with the date palm has been applied to a number of our new and promising industries. The date palm was one of the first to be studied in this way and its scientific life history investigated. The results of these investigations, published some four years ago, enabled the Department to predict with reasonable certainty not only those regions where date culture was promising, but the particular varieties most likely to succeed. These predictions have been the means of saving thousands of dollars which otherwise would have been lost through the attempted culture of choice late-ripening dates in localities where they could not possibly have succeeded. During the spring and summer of 1907 a new date garden was established at Indio, Cal. This garden is high enough above sea level to be free from danger of overflow from the Colorado River, whose overflow at one time threatened to overwhelm the cooperative date garden at Mecca, Cal., some 10 miles to the eastward and 100 feet below sea level. A new date garden has also been established at Laredo, Tex., in a part of the Rio Grande Valley where the climate in spring and early summer is the hottest in the United States. It is believed that good dates can be grown in this part of Texas. The date palms in the Mecca garden, now from 2 to 3 years old, have begun to fruit freely, and the famous Deglet Noor and a number of other choice varieties have ripened perfectly, in spite of the fact that the season has been unusually cool. During the past year much interest has been taken in the planting of seedling date orchards in the hope of securing new varieties better adapted to American climatic conditions. Altogether some 150,000 date seeds have been planted in cooperation with growers in California, Arizona, and Texas. These growers will receive one or two offshoots from imported date palms for every 250 date seedlings set out in proper form.

PERUVIAN ALFALFA.—As another feature of the life-history work to which reference has been made, the past season has brought to light a new variety of alfalfa from the high table-lands of the Andes which is even more distinct from the ordinary alfalfa than the promising new sorts introduced from Arabia. Ability to grow at lower temperatures than any other known alfalfa enables this Andean variety, the seed of which was obtained from Peru, to grow throughout the winter in some of our Southwestern States. This form passes without injury through frosts which kill all ordinary alfalfas, while it is almost completely winterkilled in all of the States from the

Panhandle of Texas northward. This paradox is explained by the fact that its ability to grow at low temperatures and the autumn frosts which force other alfalfas into a dormant state do not cause this variety to cease growth and harden up its tissues.

HARDY CITRUS FRUITS.—Life-history studies are being applied also to questions concerning the further development of hardy citrus fruits. It has already been pointed out in previous reports how these hardy citrus fruits have been obtained by cross-breeding. In the spring of 1907 a large number of additional hybrids were made with a view to still further improve these types. In studying the life history of oranges a point has been developed which is of great importance in the matter of its hardiness. It is found that most oranges suffer from being forced into growth by warm spells of weather in winter; as soon as they have pushed into a tender growth they are injured by even a very mild degree of cold, which would be without effect on thoroughly dormant plants of the same variety. Studies now being made have for their object the securing of oranges which harden up their wood thoroughly in winter and are not easily forced into new and tender growth.

DROUGHT-RESISTANT OLIVES.—With the opening up of territory in the new Southwest heavy demands are being made upon the Department for information and light regarding the best crops for this extensive dry-land country. Southwestern Texas is a promising field, especially in the matter of arborescent crops. Investigations made in southern Tunis by an expert of the Bureau of Plant Industry have revealed the existence of extensive olive orchards in that region carried on where the annual rainfall is sometimes below 10 inches for several consecutive years and where the annual evaporation is over 100 inches. The olive grown under these extreme dry-land conditions has been imported and shows every promise of doing well in some parts of Texas and Arizona. Steps are being taken to establish experimental orchards of these drought-resistant olives in a number of sections throughout this southwestern region.

WILD FRUITS OF VALUE AS GRAFTING STOCKS.—Studies made the past year in the Southwest have revealed the existence of a number of species closely allied to the almond and peach of the Old World. Several of these occur in very dry situations and one is distinctly of promise as a stock upon which to graft almonds, apricots, and other stone fruits for culture on unirrigated lands. Another species growing in central Texas bears a very early ripening fruit of fair size which is said to be of delicious flavor. Plants of this "wild peach" have been secured and selections will be made with the hope of obtaining a native drought-resistant peach-like fruit which can be grown in regions where peaches do not now succeed.

COOPERATION WITH THE INDIAN SERVICE.—In carrying out these plans of experimental and demonstration work in the southwest, the Bureau of Plant Industry has secured the cooperation of the Indian Service. A testing and demonstration farm has recently been established on the Pima Indian Reservation at Sacaton, Ariz. The Office of Indian Affairs, Department of the Interior, furnishes the land, water, and labor, and the Department of Agriculture plans the experiments and furnishes all the necessary seeds and plants. The Indian Service is well equipped with lands and well-trained superintendents, and their cooperation will make it practicable to carry on demonstrations with numerous dry-land crops, such as alfalfa, dates, figs, olives, etc.

PROGRESS WITH FORAGE CROPS.

In addition to the special work on forage crops connected with foreign introductions and life-history investigations, the Bureau of Plant Industry has a corps of efficient officers and men engaged in investigations having for their object the extension of important forage crops already here, especially alfalfa and grasses. This work also has for its object the improvement of important crops of this nature and the introduction of these improved types or strains wherever they are likely to prove of value.

EXTENSION OF CULTURE OF ALFALFA AND OTHER LEGUMES.—The introduction of leguminous crops throughout the different farming sections of the country is considered of the highest importance. The future maintenance of fertility is based on a wise use of such crops. During the year extensive work was carried on, having in view the extension of alfalfa culture into those portions of the country where it is not now a staple crop. About 500 carefully planned experiments were conducted with farmers the past season in cooperation with State experiment stations. In general, cooperators have shown much enthusiasm in these experiments and have spared neither time nor expense to make their work successful. The effect of successful work of this kind in stimulating neighboring farmers to undertake the culture of the crop is especially gratifying.

ENCOURAGEMENT OF ALFALFA SEED PRODUCTION.—The great interest in alfalfa growing throughout the country has created a much larger demand for alfalfa seed than our farmers have been able to supply. This has brought about the heavy importation of foreign seed, some of which has been shipped even to the Pacific coast. With the enormous area devoted to alfalfa in this country we should be exporting seed rather than importing it. Investigations have shown that the yield of seed per acre is partly determined by the cultural methods used and is partly dependent upon varietal characteristics. Both

these lines of investigation are being vigorously prosecuted so as to bring about a great increase in the production of American alfalfa seed.

LARGE YIELD OF ARABIAN ALFALFA.—One of the most promising alfalfas tested during the year is the Arabian type. At Mecca, Cal., this alfalfa has yielded twelve cuttings in the year as against eight cuttings for ordinary alfalfa. At Chico, Cal., seven cuttings of the Arabian were obtained as against five of the ordinary.

IDENTITY OF GRIMM ALFALFA WITH SAND LUCERN.—It has also been discovered during the year that the Grimm alfalfa, which is recognized as an important one in Minnesota and other regions where the winters are severe, is in every way identical with the so-called sand lucern much cultivated in Germany and Bohemia. The Bureau has been making special efforts to extend the culture of the Grimm alfalfa throughout the cold regions of the Northwest, but has been limited in this effort by lack of seed. A much wider utilization of the Grimm alfalfa can now be made practicable, as we can secure seed in large quantities from Europe.

IMPROVED TIMOTHIES AND OTHER GRASSES.—A special effort was made during the year to enlarge the scope of the work on improving grasses. The rapidity with which such important grasses as timothy can be improved has already been pointed out. During the year two of the State experiment stations have also taken up this line of investigation. The seed of improved timothies described in previous reports has been distributed for experimental purposes with encouraging results. Work on other important grasses has also been undertaken. Brome-grass, orchard grass, redtop, and meadow fescue have received special attention in this direction.

ENCOURAGEMENT OF COWPEA CULTURE.—One of the most important forage crops, for the South at least, is the cowpea. During the year extensive investigations have been made of this crop, the principal object being to secure cheaper and better seed so as to bring about a great increase in cowpea culture. Special machinery has now been developed for harvesting the upright-growing varieties. The need is for good varieties producing small, hard seeds that will not crack and that retain their vitality for more than one year. Many new varieties have been secured from foreign countries and a large number of others developed by hybridization, some of which show great promise. The cowpea is to the South what clover is to the North, and the lessening of the cost of the seed and the improvement of varieties are the two important problems that need to be thoroughly pushed.

EXTENSION OF SORGHUM CULTURE.—The various varieties of sorghum have been receiving special attention with a view to their utilization, especially in the South, where the rainfall is more or less

deficient. A large amount of seed of improved and pure-bred strains will be available for distribution in 1908. Among the numerous new introductions that are of great promise are two from Natal, one a black-hulled Kafir, having large elongated heads, the other a new type called Pink Kafir, characterized by rather large pink seeds and dense heads. A new sweet sorghum of unknown origin was discovered under cultivation in a single locality in Texas. It is the sweetest variety yet tested and will be disseminated under the name of Honey Sorgo. All these sorghums are proving valuable not only for forage but for grain throughout the Southwest, and their wider introduction is of considerable importance.

SOY BEANS FOR ROTATION ON RICE LANDS.—The rice growers of the South, especially in Louisiana and Texas, have long felt the need of a legume that might be grown in rotation on their rice lands. The Department has been successful in introducing a specially adapted variety of soy bean used on the rice lands of central China. These soy beans have been tested and give every promise of filling the need perfectly. Three varieties have been secured, all very similar and characterized by great leafiness, fine stems, and large size, becoming 6 feet high, so that they produce large crops of excellent hay. Thus we have a combination of crops which will, we hope, do for the rice grower what clover does for the wheat fields of the North, serving not only as a valuable soil improver but an important forage crop as well.

DISCOVERY OF AN EARLY-MATURING VETCH.—Other important investigations with forage crops have had to do with the introduction and encouragement of the growing of vetches throughout the South. The vetch is an exceedingly important plant and its much wider use is greatly to be desired. The principal difficulty in securing an extended use of these important plants has been the fact that they can not be harvested in time for cotton planting. The recent discovery of a valuable new vetch which matures as early as the so-called native vetch of the South and which produces very satisfactory crops will, it is believed, obviate this difficulty and result in its extensive employment. Seed will be available for distribution and trial next season.

IMPROVING THE CORN, COTTON, TOBACCO, AND OTHER CROPS.

The special work of the Bureau in the improvement of plants by breeding and selection has been pushed forward during the year with vigor.

BREEDING BETTER STRAINS OF CORN.—Extensive cooperative investigations have been carried on in the matter of corn improvement. Breeding for greater yields, improvement in forage, improvement in

sweet corn, and other lines of work have been carried on in cooperation with several experiment stations and with a great many individual farmers throughout the country. Demonstration plots of corn in considerable areas have proved the most successful way of interesting the farmers in this important work. These farmers after a time supply greatly improved seed, thus advancing the work throughout an entire neighborhood.

METHOD OF SEPARATING COTTON SEED.—In the cotton improvement work the introduction of practical methods of seed selection has enabled the cotton growers to get rid of light, inferior seed, and as the result of this work, which has aroused great interest, the yield has been increased from 10 to 15 per cent. The apparatus devised for the purpose of separating the seed has been improved so that it is possible to separate cotton seed into heavy and light seed at a very small cost.

BREEDING COTTONS TO ESCAPE WEEVIL INJURY.—Improved and early varieties of cotton are being secured for growing in the boll-weevil districts. Seed of these varieties will be extensively distributed the coming season to the growers for testing purposes. The work of breeding improved varieties of cotton adapted to different conditions in various parts of the South has been continued and further work along this line inaugurated. Extensive selection of the best plants in the cotton fields has been made. Many new hybrids and various crosses have been tested and some promising results obtained. The principles worked out at the Texas Agricultural Experiment Station, in cooperation with this Department, for the purpose of securing cottons of early maturity, were briefly described in my last report. These principles were applied this year by a large number of farmers, with the result of great increases in productiveness for the selected sorts as compared with the unselected. This work has been carried on in the heart of the boll-weevil region, and, we believe, is so far advanced now that it may be discontinued, as the farmers themselves can well continue it. The results, in brief, mean that every farmer has it within his power to breed productive strains which will so mature their cotton as to give yields exceeding those of old varieties and at the same time in such a way that the injury from the boll weevil will be largely minimized.

INSURING A STAND OF EARLY PLANTED COTTON.—In connection with this work some important investigations have been conducted with the object of insuring a stand of early planted cotton. One of the greatest difficulties in early planting is rotting of the seed or the death of the young plant as a result of unfavorable weather conditions and methods of planting. The ordinary depth of planting ranges from 1 to 2 inches, usually upon a soft seed bed. The result of planting at this depth, and the condition of the seed bed under

unfavorable weather conditions, is that the seed rots or the plant is exhausted before it gets through the ground. It has been demonstrated the past year that very shallow planting upon a firm seed bed that is so shallow as to scarcely cover the seed produces plants that make a good strong root, that do not exhaust their energies in getting through the ground, and that are less subject to damping-off and will make a good stand of cotton, even though the weather conditions are extremely unfavorable. The result of this work is believed to be of fully as great importance as the use of early maturing varieties in securing a profitable early crop. The principal shortage in the cotton crop in some localities this year is due more to the failure to get a stand of the early planted cotton than to any other cause. Demonstration work has proved conclusively that good stands could be obtained by shallow planting methods, despite unfavorable weather conditions.

ACCLIMATIZATION OF EGYPTIAN COTTONS.—Numerous attempts have been made to grow Egyptian cottons in this country. During the year gratifying progress has been made in this work, Egyptian cotton of the Mit Afifi variety having been grown quite successfully under irrigation at Yuma, Ariz. One selection has yielded at the rate of 500 pounds of lint per acre, which is unusually high for Egyptian cotton in this country. Some of the improved Upland strains have also given equal and even superior yields in this region. The Upland varieties that seem at present most promising for this important agricultural section of the Southwest are the Southern Hope, Sunflower, and Columbia, the latter being a variety improved by the Department in South Carolina.

BREEDING IMPROVED TOBACCOS.—All tobacco work of the Department was, in accordance with the action of Congress, taken up by the Bureau of Plant Industry the first of last July. One of the most important results of the past season's investigations has been the introduction of the new varieties of tobacco which the Department has originated. The Brewer and the Cooley tobaccos have given increased yields of a better grade of cigar-wrapper tobacco than the unimproved varieties, and in those sections where they have been tested many of the large and successful growers are planning to use these varieties exclusively next season as the result of the favorable experience of the past year. The new and improved types of Sumatra varieties of cigar-wrapper tobacco are being adopted by growers in Florida and the Connecticut Valley for growing under shade. They rank among the best varieties of cigar-wrapper tobacco now grown. Other new varieties are being tested in the various sections of the tobacco-growing States, some of which have been found to be valuable. A nematode-resistant type of cigar-wrapper tobacco has

been produced in Florida. In view of the great annual loss sustained by southern tobacco growers from this injury, the production of a resistant variety is of the greatest importance to the growers. Considerable quantities of seed of the various new varieties of tobacco will be distributed to interested growers this winter for use next season. The demand for such seed in sections where the tobaccos are grown is already beyond the quantities available for distribution. However, sufficient seed has been saved to give to the growers a limited supply, consistent with the introduction of new and improved varieties.

IMPROVEMENTS IN HANDLING THE TOBACCO CROP.—Improved practical methods of seed selection and seed separation for tobacco have been discovered by experiments and are proving to be of benefit and practical value to all tobacco growers. At the various experimental fields where the tobacco work of the Department is being carried on thousands of farmers have visited the places and have secured from observation the benefit derived from this work. Improved methods of preventing damage from pole burn in the curing sheds have been devised as a result of experiments carried on in different parts of the country the past season. Extensive laboratory work has also been carried on in the matter of the nicotine content of tobacco. The demonstration work in various parts of the regions where the different tobacco types are grown has been continued, with encouraging results.

BREEDING DISEASE-RESISTANT ASPARAGUS AND OTHER CROPS.—Aside from the foregoing a number of general problems in breeding have been under investigation. The question of securing rust-resistant varieties of asparagus has been given special attention during the year. The rust disease of asparagus is threatening this industry in a number of sections and the efforts being made are for the purpose of securing types which will be resistant or immune to the disease. The Bureau of Plant Industry is cooperating with the Massachusetts Experiment Station in these investigations.

Work in the breeding of wilt-resistant melons was practically completed during the year. The new wilt-resistant hybrid melon, to which attention was called in my last report, was grown on a commercial scale during the past season and easily held its own in the market with the varieties of its class. It produced an excellent crop on land where ordinary melons were destroyed by wilt. In connection with the breeding of wilt-resistant cotton further tests have been carried on with Upland cottons. Some of these Upland wilt-resistant types have not only proved valuable from the character of their lint but also from the quantity of fiber produced. Considerable work has also been carried on in the matter of breeding alkali-resistant and drought-resistant plants. This work has included such crops as cereals, forage crops, grasses, and sugar beets.

WORK IN THE IMPROVEMENT AND EXTENSION OF GRAIN CROPS.

This important line of investigation has been continued in much the same way as touched upon in my previous reports.

DURUM WHEAT.—Efforts to still further extend the durum wheats have continued. The successful production and utilization of this wheat continue, notwithstanding the numerous unfavorable comments and predictions made in reference to it since its introduction seven years ago. Twenty million bushels of last year's crop were exported to Europe. Of the remainder all except a seed reserve went rapidly into domestic consumption, chiefly for bread flour. It is certain, from official figures, that over 6 million bushels were ground in Minneapolis mills. Probably 10 million bushels were used in the country mills of the Northwest. In Minneapolis a large portion of this wheat was blended with Hard Spring, although a considerable amount of straight semolina was made for macaroni factories. In the country mills a considerable quantity of pure durum wheat flour was made.

The 1907 crop of durum wheat in the Northwest is probably about the same as that of last year. It is difficult to follow its extension everywhere. The acreage in the Middle West and Southwest is now, however, becoming important, and the production in those areas this year is probably about 5 million bushels. There is now also a considerable acreage in Montana, Idaho, Oregon, and Washington. Of this new crop over 8 million bushels have been exported to November 1. An important feature of recent shipments is that large amounts are going to northern Europe for bread flour. One-fourth of the entire export is being used in Great Britain. Recently durum wheat was preferred in Antwerp over No. 2 Red Winter, the latter selling at 2 or 3 cents less per bushel. A dozen or more cars per day are at this time being received in Chicago, all of which is sold to domestic mills.

Statements recently made that durum wheat is deteriorating are found, after investigation, to be incorrect. Samples from certain localities, particularly in the Red River Valley, where it should not be grown, have a large proportion of white, soft grains, but the larger part of the present crop is of good quality.

EXTENDING THE WINTER-GRAIN AREA.—The Bureau has made a special effort during the year in the continuation of the work of extending the winter-grain area in the Middle West and the North Central States. Grain-growing conditions in these sections have been greatly improved through the introduction by this Department of winter hardy varieties adapted for autumn seeding, the testing and distribution being accomplished in cooperation with the State experiment stations. Tennessee winter barley is now fairly well known throughout Kansas, and is giving from 30 to 50 per cent better yields than spring

barley every year. The use of Kharkof wheat has virtually established winter-wheat production over considerable portions of Nebraska, Iowa, and South Dakota.

INTRODUCTION OF EMMER.—Emmer, the grain about which the Department has already published some information, is being more and more recognized as a good stock food and is found well adapted to the dry-land areas. More recently the Department has successfully established a winter hardy variety, which, in addition to the qualities of the ordinary spring-sown emmer, furnishes good fall pasturage.

MISCELLANEOUS GRAIN PROBLEMS.—As agriculture gradually extends into our western sections demands come for information relative to grains suitable for high altitudes. In response to these demands experiments with hardy varieties have been inaugurated at several points of high elevation. Tests of the most promising sorts have also been made under field conditions in cooperation with farmers. Hull-less barley, early oats, emmer, durum wheat, and spring rye are found to be particularly suitable for these districts. The important work on the study of grain diseases, investigations of rice and rice varieties in the South, and the improvement of grains have been continued.

SOIL BACTERIOLOGY.

The work in soil bacteriology has been extended during the past year to include the whole question of the relation of bacteria found in soils to fertility and crop production. Outside of the work of the Department and two of our experiment stations, very little has been done in this country on this general subject.

RELATION OF BACTERIA TO FERTILITY.—Though this work has not gone far enough yet to warrant any general statement of results, it has been shown that the failure of nodule bacteria in certain soils is due to the presence in the soils of certain bacteria antagonistic to the nodule form, and that if these antagonistic forms can be removed leguminous crops can be grown and successfully inoculated on these soils. In other cases it has been found that certain soils otherwise in good condition lack effective nitrifying and ammonifying organisms, these soils being improved in fertility when these organisms were supplied.

DISTRIBUTION OF INOCULATING BACTERIA.—The distribution of bacteria for inoculating various legumes has been continued during the past year with increasing success. It has been found especially important to carefully examine soil conditions before inoculation, and a method of doing this quickly in the laboratory has been devised, based on the soil-solution work of the Bureau of Soils. Over 18,000 cultures have been distributed during the year, and, from the reports received to date, they have been used with success in the majority of cases.

STUDIES OF WATER CONTAMINATION.

In the water purification work principal attention has been given during the past year to the study of the conditions of water supplies, especially on dairy farms.

IMPROVEMENT OF FARM WATER SUPPLIES.—The results of the work showed that the water supplies on a large percentage of dairy farms, especially in the vicinity of Washington, D. C., were in very poor condition, and as the work has extended it has been found that the condition is apparently as bad in other localities. This line of work is especially important, not only to dairy farms but to farms in general, and the Bureau of Plant Industry, cooperating with the Bureau of Animal Industry and the Public Health and Marine-Hospital Service, will do everything possible to improve these conditions.

WORK IN THE CANAL ZONE.—A great deal has been done also in the treatment of reservoirs for algal pollution. Probably the most striking treatment was that carried out under the direction of the Department experts in the Panama Canal Zone, the work there being highly successful and satisfactory to the canal authorities.

FRUIT INVESTIGATIONS.

Investigations of the marketing, transportation, and storage of fruits have been continued along the lines mentioned in my last report. The grape work and fruit district investigations have also been continued.

METHODS OF MARKETING APPLES.—Particular attention has been given to methods of packing and handling winter apples. Investigation of foreign shipments of these apples indicates that more than 20 per cent of such shipments are classed as "slack," caused by insufficient shaking of the barrels in packing, insufficient filling of the barrels, over-ripeness at harvest, and careless and rough handling.

IMPROVEMENT IN HANDLING AND SHIPPING ORANGES.—Investigations of the causes of decay in oranges from California were continued. Practical demonstrations and trial shipments have shown the results of different methods of packing, handling, and shipping upon the keeping quality of the oranges. This work continues to have the support of all those interested in the citrus fruit industry, and the methods of handling the crop are being changed in many respects. Reliable authorities have estimated that the improvements already effected have resulted in an annual saving to the industry of from one-half million to one million dollars. Preliminary investigations have been begun to determine the causes of losses in Florida oranges, and it has been demonstrated, as in California, that the rough mechanical handling of the fruit is one of the principal causes of the trouble.

PROGRESS IN GRAPE INVESTIGATIONS.—In connection with the grape investigations, additional resistant varieties have been planted at each of the cooperative vineyards in California, and the work is progressing satisfactorily.

SUGAR-BEET INVESTIGATIONS.

During the year investigations of sugar-beet growing have been continued along lines similar to those discussed in previous reports.

PRODUCTION OF AMERICAN-GROWN BEET SEED.—The development and improvement of American strains of sugar-beet seeds have been continued. This work is carried on in a number of States and the results have already been very encouraging. Large quantities of American-grown seed have been distributed to farmers, and cooperative experiments were inaugurated whereby it was made practicable to test the seed grown in this country alongside of the best European seed. In all cases the American seed has been found equal to and, in a number of instances, superior to the foreign-grown product.

RESULTS OF THE YEAR'S WORK.—The special investigations pointed out in previous reports in the matter of breeding beets of high sugar content have been carried on mainly in the State of Washington. The studies on the development of single-germ beet seed have also been continued with encouraging results as to progress. We now have these beets giving progeny of high sugar content and yielding 50 per cent of seed of single germs. During the year a number of diseases of the sugar beet have been investigated and further work has been carried on in the matter of testing fertilizers for the purpose of increasing the tonnage. Some investigations have also been inaugurated in the matter of handling the beets, rotation of crops, and other subjects of a similar nature.

From the latest information it would appear that the sugar production of the country for the year just closing will amount to approximately 500,000 short tons. Our representative reports that crop results throughout the sugar belt are checking out very closely those of last season. There will be three or four more factories in operation than last year. Two or three factories new last year will work a larger tonnage this season. The tonnage of sugar will in all probability approximate from 20,000 to 30,000 more this year than last. The crop in Colorado is from all appearances a little heavier than that of last year. In California it is a little lighter. In Wisconsin and Michigan the crop is fairly good and about the same as that of last season. Colorado will come close to 200,000 tons of sugar. Altogether the industry is in a prosperous state.

STUDIES OF POISONOUS PLANTS.

Investigations of plants poisonous to stock have been continued during the year with encouraging results. The causes of a number of serious outbreaks of stock poisoning have been investigated and remedies prescribed. Some important results have been obtained during the year in the matter of loco poisoning, its cause and remedies.

COOPERATION WITH THE FOREST SERVICE.—In connection with the work of the Forest Service important questions have arisen regarding injury to stock through the eating of poisonous plants. The Bureau of Plant Industry has entered into cooperation with the Forest Service, whereby examinations of this nature will be made with a view to taking steps for the prevention of losses in the future.

THE GROWING OF DRUG CROPS AS A NEW INDUSTRY.

It has been pointed out in previous reports that from 10 to 15 million dollars are sent abroad each year for the purchase of drug crops, many of which could be grown here. With a view to determining the conditions of soil and climate where these drug crops will grow to the best advantage, experimental work has been under way for some time.

ESTABLISHMENT OF THE CAMPHOR INDUSTRY.—Drug gardens are now established at a number of points, and as a result of this work it is believed that the camphor industry has been established on a firm basis. A large acreage is being planted to camphor in Florida, and interest in the growing of this crop is shown elsewhere. From 3,000 to 4,000 acres of the trees are being prepared for planting in Florida alone.

PROGRESS IN SEED STUDIES.

The Department is making a special effort to educate the farmer in the matter of good seeds. With this end in view many thousands of tests have been made during the year, both for seedsmen and for farmers.

DECREASE IN PRACTICE OF SEED ADULTERATION.—The work on seed adulteration has been continued with gratifying results. Aside from the continued sale of Canada bluegrass seed for Kentucky bluegrass seed, fewer cases of adulteration have been found than in former years. The importation of low-grade red-clover seed has continued, some lots containing over 8,000,000 weed seeds per bushel.

INVESTIGATION OF DODDER INJURY.—During the year special attention has been given to the loss caused by dodder infesting clover and

alfalfa. Dodder has proved such a serious pest the past year throughout the world that the International Seed Control Congress at Hamburg, in September, 1906, took action toward encouraging all governments represented to adopt measures for the extermination of this pest.

CONGRESSIONAL SEED DISTRIBUTION.

The work of securing, packeting, assembling, and mailing the seed for Congressional purposes was carried on the same as in past years. This work is now so systematized that it goes along smoothly, despite the large quantities of seed that must be secured and sent out. The total number of packages put up and distributed has remained the same for the past six years. In the annual distribution 6,400,000 packages of miscellaneous vegetable seed are put up and sent out, each package containing 5 packets, and 800,000 packages of flower seed are put up and distributed in the same way, each package containing 5 packets.

EXPERIMENTAL GARDENS AND GROUNDS AND ARLINGTON FARM.

The Department grounds have been further improved during the year by the addition of a large number of new shrubs and trees and by repairs to the greenhouses and fences. A new greenhouse has been constructed during the year, which is a model of its kind. Over 90,000 plants of many varieties were propagated and distributed, and the important hybridization work which the Bureau is carrying on was continued with satisfactory results.

WORK OF THE ARLINGTON FARM.—Many problems of a general nature connected with crop growth and crop conditions are being worked out at the Arlington Experimental Farm. The Forest Service, the Bureau of Entomology, and the Bureau of Soils have each been allotted certain areas for working out problems pertaining to their respective investigations. The greater portion of the farm, however, is used for the various lines of work conducted by the Bureau of Plant Industry. The drug garden has been successfully established, the peach orchard has now begun to bear, a small cranberry bog has been established, and extensive tests with beets and radishes have been conducted at the testing gardens. The condition of the soil on the farm has been greatly improved during the year. Two additional greenhouses have been constructed and other improvements have been made.

HELPING THE FARMERS IN THE BOLL-WEEVIL REGION.

The Bureau of Plant Industry has been engaged for the last three or four years in encouraging the diversification of crops, the improvement of systems of farm management, and the handling of farms in

the sections invaded by the boll weevil and those in which it would seem that the boll weevil is likely soon to appear. This general propaganda work has been under the supervision of a representative of the Department, with headquarters at Lake Charles, La., and has met with great and continued success. The object of the work is simply to bring to the attention of the farmer plain and practical methods of bettering his condition, improving his soil, and growing larger crops. Diversification is taught as far as it can be taught under existing circumstances. The people are reached largely by personal contact with representatives of the Department. Close touch is kept with all those who are working in order to determine definitely the difference in actual money returns from farms or portions of farms handled by the old methods and on the newer plans. During the past year the Department cooperated in this way directly and indirectly with more than 100,000 farmers in the more important cotton States.

GRAIN STANDARDIZATION.

Attention was called in my last report to the unsatisfactory methods of handling and grading grain now in vogue. The laboratories established at Baltimore and New Orleans have continued to receive the cordial cooperation of all interested in the handling of grain and have determined some of the more important factors entering into the question of standardizing present methods and grades.

DEVELOPMENT OF MOISTURE-TESTING APPARATUS.—The moisture-testing apparatus introduced last year by the Department has been used with great success in these laboratories. This apparatus has been adopted by many commercial organizations, and they report that it has been of the greatest value to them in determining the moisture content of grain. This apparatus enables us to determine the moisture quickly and accurately, making it entirely practicable for use under commercial conditions.

ESTABLISHMENT OF NEW LABORATORIES.—Additional laboratories have been established at Duluth, Minneapolis, St. Louis, and New York. At Duluth and Minneapolis special attention is to be given to finding the best method of accurately determining and measuring dockage. Through the work of these laboratories and the general investigation of grain-trade conditions the Department is coming into possession of much valuable information which should enable it to be of great assistance in straightening out the unsatisfactory conditions now existing.

NEED OF UNIFORMITY IN INSPECTING AND GRADING GRAIN.—It becomes more and more evident as this work progresses that some uniform system of inspecting and grading grain is absolutely imperative. Our producers of grain suffer through the lack of uniformity

in grading, and our markets abroad are injured by lack of confidence in the grades established. It is believed that the end to be attained is through National inspection of all grain entering into interstate and foreign commerce, and the attention of Congress is respectfully called to this important question.

FARM MANAGEMENT.

Farm management investigations have been continued during the year along the lines set forth in previous reports. For the purpose of systematizing the work the country is divided into sections and the systems of successful farm management in these sections is being studied by experienced men.

CROPPING SYSTEMS FOR STOCK FARMS.—From data which have been thus secured the Bureau has been enabled to outline and plan cropping systems to meet the needs of those desiring specific information along these lines. During the year a simple method of planning cropping systems for stock farms has been developed and such systems have been worked out and applied to a number of farms in various parts of the country.

ENCOURAGEMENT OF DIVERSIFICATION OF CROPS.—In many sections of the country it is found that systems of farming have been developed based on a single crop. Frequently this crop is grown year after year on the same land and forms the sole basis of the farmer's income. Such systems are found in some of the wheat-growing areas of the Plains region and the Far West. In these sections the land is becoming infested with many bad weeds. In some parts of the corn belt corn has been grown continuously for sale until the land has become depleted and insect pests are gradually reducing the yield of corn. In the Southern States the continuous clean cultivation of cotton has destroyed the humus of the soil and yields are unsatisfactory. In all these instances the Department of Agriculture is working out systems of diversified farming which provide for the maintenance of fertility and render the farmer less dependent on the single source of income.

STUDIES OF METHODS ON SUCCESSFUL FARMS.—Realizing that preeminently successful farms have solved many of the most important problems confronting farmers in this country, experts in farm management in this Department have continued the study of such farms with valuable results. The success which a few men have attained in farming has in no case been due simply to good judgment in buying and selling. In every case thus far studied success has been due not only to good business methods, but to the application of the teachings of science in crop production and in the care and management of stock. Farmers of this class are invariably well

informed concerning scientific investigations relating to farming. During the year careful studies of several successful farms have been completed and the results have either been published by this Department or are now in course of preparation for publication.

VALUE OF THE PRICKLY PEAR AS STOCK FEED.—As a special investigation the Office of Farm Management has made a study of the prickly pear as a farm crop during the year. Conservative estimates based upon actual feeding tests and upon yields obtained from cultivated fields show that 1 acre of cultivated pear will furnish roughage for one cow the year round. An average production of nearly 23 tons of green feed per acre per annum has been grown upon the experimental grounds near San Antonio, Tex., during the past three years. The native growth has been used as stock feed for many years, but its cultivation was never attempted until three years ago. The response to cultivation has been remarkable, eight times as much forage being produced upon cultivated ground as upon uncultivated ground. When it is considered that the crop economizes labor, that a plantation is good indefinitely when once established, that it can be fed in a succulent condition every day of the year, that it is relished by nearly all farm stock, and that it is extremely resistant to drought, it is clear that this crop must become an important adjunct to the live-stock industry of the Southwest.

FOREST SERVICE.

RETURNS FROM THE NATIONAL FORESTS.

At the beginning of the fiscal year the area of the National Forests was less than 107,000,000 acres; at its close, more than 150,000,000 acres. Nearly all the timber land of the unappropriated public domain is now under actual administration by the Forest Service. This means that it is being protected against fire, theft, and wasteful exploitation, that its power to grow wood and store water is being safeguarded for all time, and that nevertheless its present supply of useful material is open to immediate use wherever it is wanted. The timber in the National Forests, which is the legacy of the growth of centuries, is now in the truest sense public property, administered for the benefit of the people—primarily for the benefit of the people of the West, since they are nearest at hand, but on the whole for the benefit of every part of the country, since the welfare of every section is interwoven with that of all others. The communities and settlers adjacent to these forests are safe from any fear of monopoly of one of the chief necessities of civilized man.

The Government is not a landlord owner, but a trustee. As a trustee it must treat all alike and refuse permission to the first comer to pocket the share of all the rest. Hence timber is given away

through free-use permits only in small quantities to the actual home maker, who comes to develop the country, and in larger quantities to communities for public purposes. Otherwise it is sold to the highest bidder, but under such restrictions as look to the maintenance of a lasting supply answering to the needs of the locality, to be had without favoritism and without extortionate demand based upon the necessity of the consumer.

Though the value of the forests as public property is not measured by what they turn into the Treasury of the Government, but by what they contribute to the welfare of the people in the States in which they lie, it is none the less a matter of striking importance that the receipts from them during the year totaled over $1,530,000, or almost exactly twice those of the previous year, and more than twenty times those of two years ago. The cost of their administration to the Government, including that part of the expenditures of the Forest Service in Washington properly chargeable under this head, were less than $1,500,000. In other words, the forests are already self-supporting, though they have been under the control of expert foresters less than three years. The total expenditures of the Forest Service for all purposes during the year was $1,825,319.50—considerably less than I estimate that the receipts from the Forests will be during the present year. As yet, however, from the standpoint of true economy the expenditure for the protection and improvement of these Forests is far too low. France spends annually upon state forests less than one-fiftieth the area of our own over $2,500,000 and realizes $4,230,000; Prussia spends upon 7,000,000 acres over $11,000,000 and realizes $17,054,144; Saxony spends upon only 400,000 acres over $900,000 and realizes $1,651,882. Yet in all these countries, unlike our own, the forests have had great sums spent upon them in the past in the form of permanent improvements, to which are largely due their present returns. A forest can no more be made to yield a constant return in valuable products without the investment of capital in improving the property than can a farm. If the United States spent as much per acre upon these forests as Prussia does upon hers, they would cost each year $250,000,000. If they brought in as much per acre, the gross revenue which they would yield would amount to $650,000,000, and the net revenue to $400,000,000. The development of the wealth-producing possibilities of the National Forests—not, it must be insisted, in the narrow sense of income yield to the National Treasury, but in that of economic usefulness to the people—is hardly begun.

I have asked for an appropriation for the Forest Service during the fiscal year 1909 of $3,200,000. This, if all spent upon the National Forests, would amount to 2 cents per acre. France spends annually

upon her state forests 95 cents per acre, Switzerland $1.32, Prussia $1.58, and Saxony $2.32. These are the countries in which the management of the forests is most profitable in products. The countries which spend most do so because their forests are brought to a high state of development. Thus utilizing their full productive powers, they derive from them a net profit which is very high. On the other hand, the countries like Sweden, Hungary, and India, which spend from 2 to 34 cents per acre, derive a very low revenue—in other words, a small volume of products—from their forests.

NATIONAL FORESTS NOT EXPERIMENTS.

It is worth remembering in this connection that these Forests have not been set aside, and the proposed expenditures are not to be made, in order to try a doubtful experiment. It is true that the practice of forestry has only lately begun to be applied to American conditions, but this is far from meaning that it is something new, untested, or of uncertain issue. It is as sure that forest land can be made to grow successive crops of trees under proper methods as that plow land can be made to grow successive crops of wheat; as sure that forests can be made to conserve the water supply as it is that manuring enriches the soil. As time passes, it will doubtless appear that the principles which centuries of experience in older countries have placed at our command can be applied with increasingly good results as we grow more familiar with our own special conditions; it may be that mistakes will be made in individual cases; but of broad success there can be no question. The issue is sharply between caring for our forests by applying a system of known efficiency, or suffering certain loss not only of the forests, but of usable water and soil as well, through the operation of causes as certain to act as are the rivers to run to the sea.

THE GAIN IN THE USE OF THE FORESTS.

The use of the National Forests by the people of the West is increasing at an extraordinary rate. The value of timber sales, the number of stock grazed, the demand for free-use and special-use permits all tell the same story. The Forests are more and more contributing to the material welfare of those in their vicinity. This is altogether as it should be. But it is out of the question to transact twice as much business and protect a much larger area of Forests without a corresponding increase in the administrative and protective force. The demands imposed by the enlarging use of the Forests diminished to a very dangerous degree the attention that could be given to the work of patrol. The force upon National Forests must be increased as the business of these Forests increases.

SOME IMMEDIATE PROBLEMS.

Notwithstanding the fact that forestry is a thoroughly tested system by which other nations have met and solved the same difficulties which now confront us, the Forest Service has many novel problems to work out. For its task is not merely to save the Forests through use, but also to find out how to make the most of them. Scattered as they are throughout the West from Alaska to Arkansas and from Minnesota to California, they grow under climatic conditions that vary from almost subarctic cold to almost tropical heat, and from the heaviest rainfall of the continent to the extreme of aridity which tree growth can endure. Just as American farming has had to develop and is still developing methods adapted to the conditions of each region to make the best use of agricultural land, so must the forester learn by scientific study and practical trial to make the best use of our timber land. And the best use means, of course, not merely its best use for the growing of trees, but its best use with reference to all interests directly or indirectly affected by it.

Through records of the effects of all cuttings made, knowledge is being gathered which will make it possible constantly to improve upon the methods employed in harvesting the timber crop and replacing it by another. Two other problems under investigation which are of special importance are range improvement and forest extension.

Unlike the demand for timber, the demand for range in the National Forests is already large enough to employ practically the full productive capacity of the land. There were grazed last year on the Forests over 1,200,000 horses and cattle and 6,650,000 sheep and goats, representing a total investment of perhaps $44,000,000 and a probable annual profit, under the conditions of recent years, of $8,000,000. Upon the cattle industry of the western range depends to a large extent the farmer of the prairie States for the profitable marketing of his corn crop, the workingman of the East for his food supply, and our foreign trade for one of its important articles of export. The entire country, with its rapidly growing population, is therefore concerned in the power of the range to supply summer feed to the stockman. Under the conditions which obtained before the Forest Service undertook to regulate grazing, the carrying power of the range had seriously fallen off through overgrazing and competition. By putting a stop to these evils the Forest Service has not only partially restored the range to its former carrying power, but has also given greater stability to the stockman's industry by recognizing his right to protection against newcomers, and made it possible for him to bring his stock through in better weight and condition. Nor is this all. An exhaustive study of the possibility of range improvement through artificial seeding, through changes in the present methods of handling stock to favor the growth of the best native forage

plants, and through extermination of poisonous plants has been inaugurated. The whole problem of range control and improvement will be pursued until every part of the range in National Forests is producing the best crops of forage which the circumstances will allow.

Forest extension opens a field the importance of which can hardly be overestimated. The fires of past years and centuries have stripped great areas of western mountain timber land of all forest growth. The need of conserving the rainfall and snowfall of these areas makes reforesting a step of urgent necessity. At the same time it is often one of the utmost difficulty. In dry climates particularly (where the need is greatest), to establish a forest without prohibitive expense calls for the most careful study of methods and of the adaptability of different species to the conditions. Even after plantations are apparently well established a season of unusual drought may turn the scale against the growing trees. Millions of acres must be planted—and this means that thousands of millions of small trees must be raised—but there is yet much to be done before planting on a scale commensurate with the needs can be begun. This preliminary work is being pushed with as much energy as the funds available for the work will permit.

In a large part of the Northwest, at least, there is good reason to believe that broadcast sowing of seed may be practicable. If this proves to be the case, the way will be open for restoring to forest cheaply very much of the burned-over land. Hitherto the experimental sowings have shown surprisingly good results. The country's need of timber is certain to be so acute before many years that the work can not be entered upon too quickly. Broadcast sowing, however, to give good results, must probably be confined to heavy seed years, when a food supply for the animal life of the forests is abundant enough to prevent too great interference with the sowings.

NEED OF A CENSUS OF STANDING TIMBER.

That the United States is even now nearing a time of severe scarcity of lumber is no longer a matter of doubt. Each year makes a further heavy inroad upon the remnant of our virgin forests, and the growth of our abused and depleted forest lands for three years would not meet our needs for one. Under these grave conditions it becomes a matter of very practical and exigent importance to know with some degree of accuracy how much standing timber we have. Many commercial organizations have, during the last few months, passed resolutions asking the Government to undertake a census of our sources of supply. The Bureau of the Census and the Forest Service are ready to act together to take such a census, if this is made possible by action of Congress, and I urge most strongly that the appropriation necessary for this purpose be made. Until it is known not only how fast our

forests are being used, but also how much is in reserve and how fast new wood is growing, our measures to meet the crisis will be planned in ignorance of some of the essential facts.

WORK OF THE YEAR.

ADMINISTRATION.

The business efficiency of the Forest Service organization was put to an extraordinary test by the work of the year. Great credit is due the members of its administrative force for the energy, patience, and good sense with which they assumed greatly increased responsibilities and discharged trying duties. The increased volume of National Forest business imposed a severe strain upon the machinery of organization and the personnel. Special mention should be made of the work of the forest rangers, the rank and file, who form, so to speak, the firing line of the Service. Their pay is low—too low for the requirements placed upon them—their responsibility great, and their life one which makes necessary self-reliance, initiative, and good judgment. The conspicuous success which the Forest Service has achieved in making the Forests useful to the people of the West is due in no small measure to the fidelity of these true public servants, performed as a part of the day's work and without thought of other reward than their own consciousness of duty well discharged. I am glad to acknowledge the indebtedness of the Department to these men.

A noteworthy gain in efficiency of organization for the handling of National Forest business was secured along two exceedingly important lines—closer harmony between the Washington office and the field force and enlarged local responsibility for the supervisors. By the one the two parts of the Service have been drawn into closer touch with each other; by the other the Service has been brought into closer touch with the public. The first was effected by bringing supervisors into the work of the central office in rotation, usually for two or three months, to take charge of the Washington end of forest business. The second involved a substantial increase of the authority of supervisors. Supervisors are not machines for receiving instructions and carrying out the orders of a bureaucratic organization which decides important questions far from the scene and without regard for local conditions, but men in real charge of the business and technical management of their Forests. They are held to rigid accountability for results, through systematic and searching inspection. Those who prove incapable of rising to the responsibility laid upon them are displaced. On the whole the ability shown by these forest officers has been a striking illustration of a characteristic American trait—the power to accept responsibility and rise to the situation as new duties and opportunities open.

IMPROVEMENT WORK ON NATIONAL FORESTS.

The special fund of $500,000 appropriated by Congress for permanent improvements on the National Forests is being well spent. Before this fund was made available the Forest Service was compelled to draw upon the sums at its disposal for the payment of current expenses, to provide whatever was spent in betterment of the Forests. Such expenditures were virtually reinvestments of a part of the income yielded by the Forests. Rangers' quarters, fences, fire lines, bridges, roads, trails, and telephone lines facilitate the transaction of business, the use of the Forests, the convenience of the public, and the protection and development of the property. The Forests were not created to be kept as wildernesses. They must be opened both to use and to habitation. In time they will increasingly be places for homes, industries, villages, and towns. The more they are made traversable and habitable the greater will be the development of their wealth-producing power. This work of development is as yet hardly well begun, for the size and capital value of the forests open a field of vast possibilities. That improvements do actually bring increased use the results of those already made leave no doubt. Provision should be immediately made for carrying on this work.

GRAZING.

Two years of trial have amply demonstrated the wisdom of the present method of range control. Since it is an essential part of that method that where the grazing privilege is sought for more stock than can be safely admitted some must be shut out, there is necessarily a certain amount of dissatisfaction among those to whom permits for a part or all of their stock are refused. Such dissatisfaction can not be allowed to weigh against what is manifestly the best interest of the community and the grazing industry itself. The only alternative, other than the old and ruinous one of permitting the range to be scrambled for by all alike, would be to grant the privilege to those willing to pay most for it. This would be a grave mistake. It is not in the public interest that the small owner who has established a home near the Forest should be crowded out by the big man, nor that those who have identified themselves with a locality should have to give way before the transient herd. The Forests serve their best purpose by promoting settlement and development. The evils of former conditions, with their rivalries, their injustices, and their wastefulness through overcrowding, are fresh in the minds of all. The purely selfish outcry of those who think themselves strong enough to look out for their own interests, and therefore object to a system which begins by asking who has the best right, is to be expected and must be disregarded.

That the system works well for the stock is attested by the excellent weight and condition which has been attained on the Forest range. No longer hustled from one place to another in hasty competition for feed, they are now brought to the end of the summer in better flesh and with fewer losses than formerly. In short, regulation of the grazing is proving beneficial to the range, to the owner of stock, and to the community. It is turning forage into money to better advantage than could be secured under any other system. Through the recognition given to associations of stockmen those who use the range have a voice in its management, while control by the Government prevents favoritism and insures even-handed justice to all.

The number of stock-grazing permits issued during the year approached 24,000, as against less than 17,000 the previous year, and the receipts were over $850,000, as against $515,000. This increase was mainly the result of additions to the number and area of Forests under administration, but to some extent also the result of improved range condition brought about by grazing control. No charge was made for grazing upon Forests proclaimed after March 1. Another year will beyond a doubt show further increase. The growing volume of business is another illustration of the greater use of the Forests. To handle it has severely taxed the present field force. The greater the number of stock on the Forests the heavier are the demands laid upon the rangers, one of whose duties it is to enforce the grazing regulations. A substantial increase in the administrative force of the Forests will be needed to handle the grazing business of another season.

Of 183 cases of grazing trespass, 165 were settled by the payment of damages. Action for criminal trespass was brought against five trespassers. The constitutionality of punishment for criminal trespass still awaits final determination through decision by the Supreme Court of the United States, but two additional decisions of inferior courts have during the year affirmed the criminal liability of violators of the regulations prescribed by the Secretary of Agriculture. The civil liability of trespassers has never been questioned.

SILVICULTURE.

The practice of forestry begins with the cutting of timber; the principal tools used in cultivating a forest are the saw and ax. Preparation of the ground for a future crop is accomplished by felling the mature growth, and control of the character of the future forest is through decision as to what trees shall be removed and what left standing, unless renewal is to be brought about solely through planting. It is, then, through timber sales that forest management is being introduced upon the National Forests.

Receipts from the sale of timber from the Forests increased threefold over those of the year before, and brought in $600,000. But a better gauge of the rate at which the demand of the public for timber is increasing is the contracts made by purchasers. When large bodies of mature timber are so situated that they can be utilized only by a purchaser who can undertake operations on a large scale, sales are made under contracts permitting the work to be continued through several successive years, a specified amount being cut each year. No contracts are made for a longer period than five years. In other words, sufficient time is given to enable a large operation to be carried through, but speculative purchases are not allowed. The sales contracted for during the year totaled 950,000,000 board feet of lumber, besides cordwood and other material, with an aggregate value for all classes of material of over $2,500,000, as against $500,000 sold the previous year.

It is evident that if the demand for timber continues no greater and prices go no higher than at present the Government will in five years be taking in from timber sales at least $2,500,000 annually, since payments will then be coming in on contracts entered into each intervening year. But the demand is certain to increase up to the full amount which the Forests can supply. Eventually it will be necessary to impose a limit to the cut, which must never exceed the rate of growth. Anything beyond this is overcutting. The farmer who fails to make one grain crop last over until the next one matures can usually buy from others, but for many communities dependent on National Forests for their supplies of wood no outside sources of supply are likely to be available. Data are now being gathered from which to compute the present stand and the rate of growth on the different forests, in order that excessive cutting may be prevented.

To become productive, however, a forest must begin to be cut over. No wood is making in a mature forest. Such a forest is simply a storehouse of wood. But after young growth gets under way the forest becomes a manufactory of wood. So far as is consistent with a proper regard for the needs of the future, all mature timber on National Forests is available for use. Waste in utilization of timber cut is not permitted; slash is piled and, if necessary, burned to lessen the fire risk; unnecessary destruction of young growth is prevented; and measures are taken to insure reproduction from self-sown seed.

The work of marking and scaling timber, enforcing contract stipulations, and other matters incidental to the sales, combined with the demands made by the free-use applications, called for the most strenuous efforts on the part of the administrative force, and often compelled the neglect of other duties.

In addition to the work on the National Forests, forest studies were carried on in cooperation with the States of California, Delaware,

Kentucky, and Missouri, and assistance was given to private owners of woodland concerning the management of their tracts.

FOREST PRODUCTS.

Hand in hand with the work which seeks to enlarge our future supplies of timber goes that which seeks to secure the best and most economical use of what we have. Important results have marked the work of the year in this line. The studies of the Forest Service in the field of wood preservation have now reached a point at which it may be predicted with some confidence that the treatment of timber for use under conditions which expose it to rapid decay will soon become widespread. This will mean a marked reduction in the drain upon our forests.

An easy and inexpensive method of treating fence posts has been perfected which makes it possible for any farmer to make the quickly decaying woods, still abundant because hitherto thought almost worthless, far more durable than untreated white oak or chestnut. Demonstrations of this method before southern farmers were received with enthusiasm. For the Middle West, where the common woods are seldom resistant to decay, the matter is certainly no less important. Essentially the same method is being applied to the butts of telegraph poles and to mine props. The enormous consumption of timber for the latter purpose and the extreme rapidity with which it decays in the dampness and darkness of the mine open the prospect of a large economy from the use of this method of treatment, which has stood a searching practical test in Pennsylvania coal mines. By applying the same treatment to timbers from the National Forests a use will be found for dead wood and a decided benefit will be conferred on the users of the timber. The work includes a study of the comparative merits of different kinds of preserving fluids.

The investigations aimed at discovering new sources of paper pulp have demonstrated that a number of woods of abundant supply, never in the past thought of for the manufacture of paper, are capable of yielding pulp of standard grade. Studies in wood distillation are establishing the practicability of obtaining turpentine from waste southern pine material.

Ten thousand separate tests of the strength of timber, largely in the form of full-sized structural beams, have established the relative value of a number of woods and proved the fitness for hitherto unthought of uses of several of them.

Studies of wood production and consumption have added materially to our knowledge of the rate at which we are drawing upon our reserves of standing timber.

BUFFALO IN WICHITA NATIONAL FOREST.

On March 25, 1907, the New York Zoological Society arranged with this Department to establish a herd of American bison on the Wichita National Forest in order to provide for the perpetuation of the species. The Zoological Society offered to send 18 buffalo of pure breed from the New York Zoological Park to the Forest. An appropriation of $15,000 was made by Congress for the purpose of fencing a buffalo pasture and providing the necessary buildings. This work will be completed early in the ensuing fiscal year. An area of about 8,000 acres is inclosed, and the herd placed under the care of a forest officer experienced in the handling of buffalo.

BUREAU OF CHEMISTRY.

INCEPTION OF THE WORK FOR THE ENFORCEMENT OF THE FOOD AND DRUGS ACT.

During this fiscal year an unusual development in the work of the Bureau of Chemistry has taken place, due to the enactment of the food and drugs act of June 30, 1906, which became effective on the first day of January, 1907.

ESTABLISHMENT OF REGULATIONS.

Previous to this date it was necessary to carry out the provisions of the law for the establishment of regulations. To this end a committee consisting of H. W. Wiley, Chief of the Bureau of Chemistry; S. N. D. North, Director of the Census Bureau of the Department of Commerce and Labor, and James L. Gerry, Chief of the Division of Customs of the Treasury Department, acting for the Secretaries of Agriculture, of Commerce and Labor, and of the Treasury, respectively, prepared a set of tentative regulations. Great care was exercised in the preparation of these regulations, not only that the provisions of the law should be executed fully, but also that there should be no unnecessary annoyance or burden placed upon the trade. The regulations were finally completed, signed, and promulgated on October 17, 1906, as Circular 21 of the Secretary's office.

Between January 1 and June 30, 1907, the personnel of the Bureau was more than doubled, the increase being divided among the clerical force, the chemical assistants, and the corps of inspectors. While work incident to the enforcement of the interstate feature of the law was in process of organization, a much more rigid execution of the law relating to imported foods was established. This was possible because under the previous laws the machinery for the inspection and analysis of imported foods had been already well organized.

SUPPORT ACCORDED THE NEW LAW.

Although up to the 1st of July no actual cases had been instituted in the courts under the food and drugs act, the moral effect of it was apparent in every branch of trade connected with the food industry. One of the most gratifying features of this preliminary activity has been the almost unanimous support accorded by the trade to the principles of the law. In most instances manufacturers of food products, as well as dealers therein, have expressed their cordial support of the act and offered their hearty cooperation in securing its execution. The importance of this fact can not be overestimated, since the difficulty of enforcement, if the entire trade were opposed, would be practically insuperable. Supported, however, not only by public opinion, but also by the active collaboration of producer and consumer, the food law will have that moral support which is absolutely necessary to secure more wholesome and properly branded food and drug products for the market.

APPOINTMENT OF FOOD AND DRUG INSPECTORS.

A civil-service examination was held to secure inspectors for the enforcement of the food and drugs act, appointments were made, and on June 3 these inspectors reported at Washington for instructions as to the policy to be pursued in the enforcement of the food and drugs act and the practical details of inspection and sampling. By June 30, 1907, the inspectors had been assigned their respective territories and had taken up temporary headquarters there. In making these assignments two objects were kept in view, namely, the location of branch food and drug inspection laboratories and the strategic positions offered by channels of interstate commerce.

ORGANIZATION OF FOOD AND DRUG INSPECTION WORK.

The board of food and drug inspection was created by the Secretary of Agriculture on April 25, 1907. The duties of the board are to consider all questions arising in the enforcement of the food and drugs act of June 30, 1906. The Bureau of Chemistry is charged under the act to perform whatever analytical work may be required for the information of the board. The board reports directly to the Secretary. Its personnel is as follows: H. W. Wiley, Chemist and Chief of Bureau, chairman; F. L. Dunlap, Associate Chemist; and G. P. McCabe, Solicitor of the Department.

Food and drug inspection laboratories are now established, or are being installed, at New York, Boston, Philadelphia, Chicago, New Orleans, San Francisco, St. Paul, Detroit, Savannah, Seattle, Buffalo, Kansas City, Denver, Galveston, Portland (Oreg.), and Cincinnati. Others will be established as the work requires.

These laboratories examine the imported samples taken at the port of entry and the interstate samples sent in by the inspectors, referring violations of the law and doubtful cases to the Washington office for action, and releasing those found to be according to law.

FOOD RESEARCH WORK.

In nearly all of the laboratories of the Bureau of Chemistry important research work bearing on practical problems in the analysis of foods, drugs, or cattle foods is in progress, the elaboration of new methods and the improvement of those in use being of the greatest importance in the examination of products under the law. Investigations illustrative of such researches are as follows: Work on the composition and adulteration of flavoring extracts and methods for their analysis; the effect of cold storage on fowl, game, milk, and eggs, in which work the bacteriological chemists play an important part; the study of canning products, such as canned corn, tomatoes, peas, catsups, etc., with special reference to the use of preservatives, including both factory inspection and laboratory experiments; methods for detection of the artificial coating of rice; a study of American honeys, involving the chemical analysis of 112 samples and the microscopical examination of the pollens found therein; an investigation of the ice cream and milk supply of Washington, D. C., in the course of which about 800 samples were examined from both a chemical and bacteriological point of view; and an analytical and microscopical examination of American cattle foods as found on the market, including 365 samples.

The question of the use of sulphur in bleaching food products has been given special attention and valuable data have been obtained, both as to the accuracy of the analytical methods employed for the detection of free and combined sulphurous acid and as to the extent of the use of this bleaching agent.

The other phase of this question, namely, the effect of sulphurous acid and sulphites as determined by physiological experiment upon 12 young men at the hygienic table conducted by this Bureau, was solved by the compilation and comparison of the data so obtained, which show unmistakably the injurious effects of this preservative, especially in reducing the number of red corpuscles in the blood.

The researches in the drug laboratory included, among others, the examination of samples furnished by the Post-Office Department of drugs sent through the mails, samples of drugs submitted by the Council of Pharmacy and Chemistry of the American Medical Association, the examination of hops and of glycerin to determine whether they were contaminated with arsenic, and of miscellaneous drug products, such as headache powders and so-called "kidney

cures." Much important work on methods has been done, including a special study of methods for the detection of enzyms in medicinal agents, especially for the purpose of ascertaining to what extent these bodies render various substances available to the human system.

MISCELLANEOUS INVESTIGATIONS.

Among other important studies conducted in the Bureau of Chemistry, having a direct and practical bearing on the agricultural interests of the country, are the following: Examination of insecticides and fungicides; study of the effects of trade wastes, particularly smelter waste, on vegetable and animal life; investigations looking to the utilization of the native wild sumac as a source of tannin; studies for the development of the wood turpentine industry, and cooperative experiments on the effect of varying climatic conditions on wheats, particularly on newly introduced varieties, and on the sugar content of Indian sweet corn.

CONTRACTS WORK.

The value of the examinations made of Government supplies furnished on contract is shown by the fact that the number of samples analyzed in this laboratory was almost doubled during the past year. The examinations on which the purchase of practically the entire supplies of the Bureau of Engraving and Printing was based alone aggregated nearly 400 samples. The varied character of the samples received makes necessary considerable research work for the development of suitable methods. Both a monetary advantage and an improvement in the character of the supplies is insured by the surveillance of this laboratory.

BUREAU OF SOILS.

There are in the continental United States 1,900,947,200 acres of land. Of this, the Tenth Census showed 838,591,774 acres in farms, with 414,498,487 acres in improved lands and 289,734,591 acres actually in crops.

With a more thorough knowledge of the soil and its adaptation to crops and the proper methods of soil management, the full extent of the agricultural development which may take place in the United States in the future is very great. The undeveloped portions of the United States are not confined wholly to the arid West, portions of which are now rapidly filling up, although this constitutes the greater part. When we realize that we have 77,000,000 acres of swamp land in the eastern half of the United States—an area equal to all of the New England States, New York, and half of Pennsylvania, or to the combined areas of Illinois and Iowa—which can be reclaimed,

and which, under the prevailing climatic conditions when so reclaimed, are exceedingly productive, and when we realize that only 16 per cent of the State of Louisiana, for example, and a smaller percentage of the State of Texas is in improved lands, the possibilities of development become more apparent.

The soil-survey work of the Bureau is the largest undertaking of the kind that has ever been inaugurated in any country. The area surveyed and mapped during the past fiscal year was 20,560 square miles, or 13,158,400 acres, and there have been completed to June 30, 1907, surveys covering a total of 139,247 square miles, or 89,118,080 acres. This area is more than 15 per cent of the amount represented by the farm lands of the United States as given in the preceding paragraph. The work has been so distributed as to include every large representative district in the United States, and has given a knowledge of the soil resources of the country far beyond what was ever conceived of before.

THE PROBLEM OF SOIL FERTILITY.

The Bureau, not content with merely showing the character of the soils and reporting upon their adaptation to crops, has, under the wise provisions of Congressional enactment, been very active in actual demonstrations of the possibilities of further development of these lands in the extension and introduction of new crops and developing new agricultural industries. In addition to this the Bureau has made a special study of some of these soils and of the soil conditions controlling fertility and crop production; and these investigations have given a new view point of the whole subject of soil science, which has aroused a new interest in soil investigations.

As in all large concepts of this character in such a complicated study as the soil and its relation to crop production, it is impossible to see to the fullest extent, while the details of the work are being developed, the broad scope that it may finally cover. It is impossible to see at the present time the bearing that some of the observations made in the laboratories may have in their application under field conditions and cultural methods, but enough has been demonstrated to indicate the substantial soundness of the position which has been taken.

One of the most important problems now confronting the agricultural public is the intelligent use of commercial fertilizers. In some sections of our country, especially in the South and East, the quantities now used are enormous, and this use is gradually extending. That the amount of money annually invested in fertilizers by the farmers of the country, now amounting to upward of $100,000,000, will continue to increase seems certain. But just as certainly a large percentage of the money—perhaps a third—is annually wasted and

brings no adequate return, owing to a lack of understanding of the soil's requirements.

This problem has been engaging the attention of the Bureau of Soils for a number of years, and it has been found that this wastage of the farmer's capital is due in large measure to incorrect ideas which have long prevailed regarding the manner in which the soils feed our crops and the influence of fertilizers upon this feeding. As might be expected from their origin, soils contain numerous fragments of the common rock-forming minerals. These fragments are accompanied more or less by alteration and decomposition products.

It is rarely if ever true that a soil is formed from any particular mineral or rock, but owing to the action of streams, winds, etc., the rock powders comprising the soil are much mixed and intermingled. Consequently it has been found that practically all soils contain more or less of all the common rock-forming minerals, containing among other things the important plant-food ingredients, potash, phosphoric acid, and lime. The important element, nitrogen, is of course supplied from other than mineral sources, either by decomposition of organic remains or from the atmosphere through living organisms.

The widely diffused minerals of the soil are all slightly soluble in the soil water, and it has been shown that this solution is the natural source of food supply for the plants. As the dissolved plant nutrients are removed, either by the growing plants or by other natural agencies, the minerals continue to dissolve and thus replenish the solution. As these minerals are so widely distributed in various soils, the mineral composition of the plant-food solution is not very different in different soils. The natural processes following evaporation at the surface of the soil, from plant leaves, etc., cause an upward movement of soil moisture from the subsoil, and often from great depths. These solutions rising from below carry dissolved mineral plant nutrients; but when they reach the surface soil the strength of the solution there is not much increased, owing to a power of absorption or the fixing of these salts which the soil possesses. Thus the soil is in a sense "enriched" by these desirable constituents, although the actual feeding medium for the plant is not essentially altered. Similarly, artificial enrichment of the soil by commercial fertilizers does not materially affect the mineral composition of the soil solution, as is popularly supposed, but has other profound and far-reaching functions which our recent researches are now making clear.

It has been found that infertility in soils is very frequently due to the presence of bodies deleterious to plant growth, and the difficult task of isolating and identifying these bodies and studying their

effects on plant growth has been undertaken in the work of this Bureau. Several of these substances have actually been removed from the soil and their properties determined. It has been shown that these bodies of organic origin result, under unfavorable soil conditions, from the decay of plant tissue, from excreta of germinating seeds, and from excreta of roots of growing plants. Under favorable soil conditions and under cultivation, proper drainage, suitable crop adaptations, crop rotations, and judicious use of fertilizers these organic bodies are absorbed or destroyed, providing a suitable and healthy environment for crops. Crop rotation is especially useful, since it has been found that the excreta of one plant are not necessarily deleterious to another kind of plant, and different species of plants themselves aid in the destruction and removal of deleterious organic substances. Of no less importance, because they are subject to better control, are the natural manures and artificial fertilizers. A rational use of these means of soil control, and especially of commercial fertilizers and soil correctives which now absorb so large a proportion of our farmers' working capital, is the fundamental problem of present day agriculture.

It is most gratifying to be able to announce such substantial progress in the investigations of the real causes for the fertility or infertility of our agricultural lands.

TOBACCO SOILS.

As a direct result of the soil surveys and of the laboratory investigations, the possibility of producing a finer textured tobacco wrapper leaf in the Connecticut Valley was taken up, and it has been developed to a point where it is assured that a leaf approaching the Sumatra tobacco in texture, but with other local and distinctive characteristics, has been produced in the Connecticut Valley; and, largely as a result of the Bureau's work in Florida, the American-grown wrapper leaf has taken a foremost rank, is being exported to foreign countries, and is taking its place in real competition with the Sumatra leaf. The interest in this shade-grown product has grown to large proportions and the extension of this industry is contingent to a very large extent upon the soil surveys which shall point out the soils upon which this desirable leaf can be produced.

On certain soils in Texas and Alabama the Cuban type of leaf has been introduced as a direct result of the soil surveys, after a thorough examination of the soils and conditions of growth in Cuba, and as a result of demonstration work by the experts of the Bureau of Soils there are now hundreds of acres of land in both of these States producing the finest filler leaf, suitable for high-grade cigars.

Of so great importance has this work appeared that an informa application has been made by officials in Cuba for the extension of th soil survey to that country, to aid them in the further developmen and the better understanding of their own soils and the improvemen of their tobacco industry.

In New York the reason for the variation in the type of tobacco ha been found in the fact that the adaptation of the soils to the differ ent varieties of tobacco has not formerly been understood or con ceived, and the entire solution of the perplexing problem of the com mercial crop in New York is now in a fair way of being solved by the utilization of the soil maps of the tobacco districts and the adapta tion of varieties and of cultural methods to the soils suitable for par ticular commercial grades.

In Ohio the whole method of fermentation and handling of to bacco has been changed, with important results in the improvement of the crop and the prevention of the losses which occurred under the old methods of handling the leaf.

In Virginia not only has marked improvement in the grade of to bacco produced been shown to be possible by the Bureau's work, but by the proper handling of the soil through modern methods of cul ture and of fertilization the lands have been left in so much better condition after the tobacco crop has been removed that without fur ther special treatment the yield of subsequent crops of wheat has been increased threefold and the lands have produced heavy crops of hay where formerly this crop was not even considered a possibility.

While the soil problems concerned in tobacco culture are receiving attention in the Bureau of Soils, to avoid any seeming conflict or duplication of work I have transferred all the cultural work in to bacco to the Bureau of Plant Industry for investigations on the further improvement through selection of seed and breeding, while the Bureau of Soils will continue its soil survey and soil investiga tions of the important tobacco districts as a basis for continued im provement and a safe development of the whole specialized industry of tobacco culture.

PRACTICAL USES OF SOIL MAPS AND REPORTS.

Incidentally the War Department has on file a complete set of the soil maps thus far made, and is supplied, at its request, with copies of all soil-survey reports as soon as issued for the information of the military service in deciding on camp sites, on the character of the soils over large districts where they may be called to operate, and for other information that may be of importance in military plans.

The Post-Office Department is utilizing the maps to a considerable

tent and frequently calls for advance copies for assistance in the cation of rural free-delivery routes. Life-insurance companies and ust companies are availing themselves of the information contained the soil-survey reports and maps in assessing risks and making vestments of money. Nurserymen and seedsmen are availing themves of the information furnished regarding the crops and fruits apted to certain soils in certain localities. Plow manufacturers are ilizing this work to the extent of modifying farm machinery for aptation to certain soils and certain regions to produce the most icient work in cultivation.

By detailed soil surveys the Bureau is furnishing expert advice on e crop adaptations of the soils in those areas where irrigation hemes are effecting a change from extensively dry-farmed wheat nches to intensively farmed fruit and alfalfa ranches.

In cooperation with the United States Reclamation Service, soil rveys are being made of the projects soon to be available for setement upon completion of the necessary storage reservoirs and nals constructed by Federal effort. The soils of many of these ojects have never been cultivated, and the newcomer to be successful ust have the best information obtainable about the soils and the st profitable crops.

The successful introduction of new crops in the semiarid region pends largely on the ability of the soil to conserve the scant rainfall. rveys have been made of many areas in this region, chiefly in North kota, to outline those soil types on which crops can be cultivated ith safety.

The soil survey reports, by calling attention to the soil resources nd the opportunities offered to acquire good farm lands at a low gure, have frequently been of great assistance to the railroad comanies in colonizing the territory in which they operate. Appreciating the value of the information contained in the reports, the railoads have in some cases arranged with the lithographic firms for pecially large editions of the soil maps for distribution among prosective settlers.

Many large-scale detailed soil surveys have been made of experient station farms and agricultural high school farms showing all f the minor differences in the soils of each farm. These soil maps ave proved of great value in connection with the various plat fertiizer and rotation experiments conducted on the different farms.

Demonstration experiments on all the various kinds of alkali land ound in the arid West have shown that the farmer need no longer read alkali, but that such land can be easily reclaimed and made roductive. The alkali problem has been satisfactorily solved and

is in reality not as serious as many of the soil problems confronting the eastern farmer.

Special study of the viticultural soils in California has shown that there is a direct relation between the soil and the color, yield, and commercial value of the grape; that there are large bodies of soil very well adapted to various kinds of grapes, and that the grape industry can be greatly extended in many parts of California.

Soil surveys and special study have shown that there are large areas of soils in Arkansas and California that are peculiarly suited to rice culture and that the introduction of this crop will prove a boon to farmers owning such land that has hitherto been held to be of low agricultural value.

Investigations of the apple soils of California have shown that there is a close relationship between the keeping qualities of the apples and the various kinds of soils on which they are grown. This is very important and should prove of great value to apple growers in planting new orchards.

Soil surveys of swamp lands reclaimed generations ago as well as surveys and special studies of unreclaimed swamps in many States have shown the possibilities of swamp soils. The knowledge that some of these reclaimed swamp lands are still exceedingly fertile after one hundred years of constant cropping without fertilizers has helped arouse a general interest in the drainage of swamps. Again, the information brought out by the soil survey that certain swamps contain lands of low agricultural value shows the importance of a thorough knowledge of the soil and its possibilities before we can plan intelligently reclamation schemes involving the expenditure of large sums of money.

The results of the work of the Bureau of Soils have been presented directly to the people of the United States through the medium of educational tours conducted in ten different States. There have been held over 100 meetings for which the Bureau of Soils has contributed speakers to discuss the results of soil-survey work and methods of soil utilization and soil management. A great interest has been manifested in these meetings, and an opportunity has been afforded for answering many questions which were presented to the speakers in connection with this work.

The Bureau has assigned men to many localities in which soil surveys have been made to advise with farmers in regard to the character of their soils, the crops which may be grown to the best advantage, and methods of handling the soils to derive the greatest returns. The demand for this character of work is increasing as the number of completed soil surveys increases.

The fertilizer requirements of extensive soil types are being determined through laboratory and greenhouse methods and field observations in order to effect a saving in the fertilizer bill of the country.

Field investigations have been made to increase crop production on extensive areas of different soil types which, with the usual methods of cultivation, do not yield particularly remunerative crops. In many cases slight modifications of the methods of mechanical handling of the land increase the crop-producing power of such soils to a marked degree. Frequently tile drainage or the use of open ditches or other simple measures has been found sufficient. In other cases increased depth of plowing, change from spring plowing to fall plowing, the growth of cover crops to protect the land from washing during the winter rains, or the incorporation of organic matter with the soil serves to render soils formerly held in little esteem of high producing value. This work is being developed as fast as possible.

The soil survey has found extensive areas of soils well suited to alfalfa culture, not only in Texas, but also in northern Mississippi and in central Alabama. It has been found that alfalfa soils occur in New York in localities where this industry has not yet been established, and in other Northern States as well. Upon some of these soils practically no other crop of high value is grown at the present time. The soil-survey work should be extended in order to outline more fully the localities where these soils exist. A special study should also be made of the preparation, the tillage, and the manurial requirements of these soils for successful alfalfa production.

The Bureau has materially aided in the development of the early truck and fruit industry in the Atlantic and Gulf Coast States. It has shown that there is a close relationship between the soils of different localities and the character of the truck crops which can be raised. The principal requirements of soils suited to early truck crops have been found to be small clay content, insuring excellent drainage and ease in cultivation and quick response to applications of fertilizers, and nearness to bodies of water, insuring freedom from frost. The soil survey has outlined large areas of land suitable for early truck and has been instrumental in the development of this important industry.

The Bureau is studying the characteristics of soils best suited to the production of the different varieties of cotton, notably the long staple and some of the improved varieties which are being used in an attempt to meet the boll-weevil conditions of the Southern and Southwestern States. Investigations have shown that types of cotton which grow to perfection upon loose sandy lands rapidly lose their essential characteristics if the seed from such cotton is planted on heavy clay soils or upon moist bottom lands.

Large areas of timber land have been cut over through a considerable portion of the South Atlantic and Gulf States and also in portions of the States bordering the Great Lakes. The proper use of these lands has not been well understood during the past, and it has frequently been maintained that with the removal of the timber these soils were of very small value. It has been found, however, that by the adoption of special methods of tillage, including the incorporation of organic matter and a moderate degree of fertilization, many of these soils are capable of producing the ordinary staple crops to good advantage. Some of these soils in the South Atlantic and Gulf Coast States have been found to correspond closely with the highly valuable truck and market-garden soils which have already been highly developed agriculturally.

Investigations have been made of the agricultural possibilities of the Piedmont section of the eastern United States. The rapid development of manufacturing interests throughout this section, with the accompanying growth of consuming population in the larger cities and towns, will soon render necessary the local production of such food supplies as are now to a marked degree shipped into these communities from remote localities. Changes from the production of staple crops to the production of special crops require careful study of the adaptation of soils to crops and the proper management of the soils and particularly of the application of fertilizers and manures. In addition, many other cities of the central and southern United States are becoming aware of the necessity for the production of a large part of the perishable food supply of such cities in near-by districts. The importance of such investigations is emphasized by the marked growth of urban population as contrasted with a slight growth in rural population, or, in some cases, with an actual decrease of population in the farming districts.

Soil surveys have been undertaken in some of the New England States to determine the capabilities of lands which were formerly cultivated to corn, wheat, oats, and other grain crops, but which since have reverted to pasturage or have been altogether abandoned. It has been found that considerable areas of the rougher, steeper lands should be planted to seedling white pine trees, in order to insure a renewal of the timber supply of those sections, and that such an occupation of the rougher lands is probably the most desirable use to which they could be put. The more favorably situated soils can be profitably used for fruit and vegetable crops, which may be raised to advantage, and a ready market can be found among the summer resorts of this section of the country. The hill pastures of this section are well suited, under proper methods of cultivation and seeding, to the production of valuable pasture and forage grasses, by means of

which the sheep industry may be reestablished throughout a considerable portion of the New England States. This would seem to be particularly desirable, as sheep do not require the extensive production of corn or other grain feed.

Careful study has been made in southern New York, northern Pennsylvania, and northeastern Ohio of approximately 10,000 square miles of hill and plateau belonging to a single soil series, over which the character of farming at the present time is not well suited to the soils or the climatic conditions. In this region there has been a continued tendency toward more extensive farming and away from specialization in crop production. In some cases attention has been called to the actual desertion of farm homes and to the coalescing of smaller farms into the larger holdings. This study has made evident the fact that the introduction of special crops, and particularly the adoption of proper methods of soil cultivation and soil fertilization, would make possible a more profitable system of farming. The present price of farm lands throughout this area is so low that these lands offer exceptional opportunities for the development of the orchard industry, animal husbandry based upon the production of grass and small grain crops, the production of white potatoes, and certain other specialties adapted to the general locality. These lands are located within a short distance of the greatest centers of population in the United States, and might be made highly productive and certainly remunerative with proper methods of crop adaptation and soil management.

SOIL EROSION.

Another line of work in the Bureau relates to soil erosion. According to the latest determinations (beginning with the classic measurements of the Mississippi by Humphreys and Abbot) the rivers of mainland United States are annually pouring into the seas fully 1,000,000,000 tons of sediment. This sediment is carried partly in solution, but chiefly in suspension, in the 35,000,000,000,000 cubic feet or more of river water drained from the United States, and is additional to the coarser detritus pushed or rolled along the sides of the swifter streams. The volume of material thus lost to the land is increasing with settlement and cultivation; it is almost wholly washed from the surface and is the very richest soil material, the cream of the soil. The value of the material is not easily fixed, but at a moderate appraisal the annual loss would exceed all the land taxes of the country. Besides impoverishing the soil, the sediment pollutes the waters, reducing their value for domestic and manufacturing purposes and endangering the lives of those compelled to use them, and causes

streams to scour their channels and build bars; and through scouring and building it compels the lower rivers to shift and overflow, thereby reducing the value of fertile bottom lands. However estimated, the loss is enormous, and the chain of evils resulting from the annual erosion of this billion tons of soil is long and complex, and leads directly back to the farm.

The nature of the soil is determined by the water within it. When rains fall or snows melt on the land, the water passes in different ways. A part evaporates directly into the air; another part (generally much larger) flows down the slopes to the streams and thence to the sea—this is the run-off; a third fraction soaks into the soil and subsoil and thence into the underlying rocks, perhaps to reappear in springs or as seepage into streams—this is the ground water; still another part is absorbed by organisms (chiefly trees, grasses, crop plants, etc.) either directly through tissues or indirectly through roots penetrating the moistened soil. Erosion is due directly to the run-off, of which the ratio is dependent partly on slope, but chiefly on the nature of the soil and its product; indeed, with any reasonable slope, a full cover of forest or grass with an abundant mulch, or a close crop on deeply broken soil, or a friable furrow slice kept loose by suitable cultivation, will so fully absorb precipitation as to curtail the run-off or even reduce it to slow seepage through the surface soil—the ideal condition and the one toward which modern agriculture should be bent. It is the third fraction—the ground water—that forms the most essential constituent of the soil, for solution, circulation, and organic assimilation are all absolutely dependent on water; indeed, the greater part of all organic tissue is made up of this solvent, which comprises a large percentage of the bodies and of the food of man and lower animals.

The ratio of ground water in the soil is vital. All soils contain more or less, though if the quantity is small it may be too firmly locked up in mechanical combinations to be available for plants, as in deserts which are naturally barren, yet burst into fruitfulness with a few acre-inches of irrigation. If the quantity is excessive, circulation may be so impeded that cultivation only settles the soil in a sodden mass—sticky when wet, baked crust when dry—while the surcharged condition prevents further absorption and sends the waters of storm and thaw over the surface to engage in destructive erosion even on easy slopes. The fraction of natural water supply assimilated by organisms is susceptible of control and increase by selection of crops and by maintaining the requisite soil texture and ratio of soil water, and these means tend directly or indirectly toward counteracting and eventually eliminating erosion. Thus water is not

merely the chief value inhering in the soil, for it is susceptible of such control as to multiply its benefits and eliminate its evils.

The immediate source of our prosperity is the soil of the American farm, and it is a National duty to see that the soil is conserved and the farm improved for the immediate benefit of the farmer and the ultimate welfare of the country. One of the richest assets of the nation is the water that falls on the farms, permeates the soil, permits organic growth, and after enriching the land flows seaward through the commonwealths to furnish substance and power and afford means of commerce; and it is coming to be recognized as one important duty of the nation to see that this water shall be so controlled and conserved as to yield the greatest benefits to the holders of the land on which it gathers, and eventually to all the people. At the same time the evils of soil erosion begin on the farm, and while they extend thence to the pollution of the streams of the States and the obstruction of interstate rivers, it is becoming clear that the remedy must begin with the farm and that it is a national duty to see that the remedy is prescribed and applied.

Some of the remedial devices may be noted. Since the chief object is to so regulate the capacity of the soil for water that it will absorb the product of each rainfall or thaw without run-off and retain the moisture for both plant supply and seepage, deep cultivation is desirable. This is useful, too, not only in bringing up fresh earth salts to within reach of the shorter rootlets, but in performing the still more important office of carrying down humus and mulch to thicken the soil and feed the deeper roots.

In flat-lying fields and tenacious soils, where the ground water moves sluggishly, deep underdrainage (preferably tile) is required. The primary effect of deep drainage is to permit both soil and subsoil to crumble and disintegrate, and through the mechanical and chemical changes thereby induced to become friable and susceptible of retaining the right amount of moisture for plant growth; the secondary effects are reduction of surface run-off and checking of erosion, and acceleration of stream flow after storms through the quicker gathering of the storm waters. The clear flow from the drains neither pollutes nor obstructs the streams, but leaves their waters in condition for ready control by other means.

On rolling farms contour cultivation is desirable; the plow furrows and crop rows should be carried along the slopes in such manner that each furrow and row will lie level; when the plow and cultivator, instead of opening runnels to be enlarged into gullies by the first storm, will close runnels and gullies already opened and form receptacles in which the storm waters may lodge until soaked into the soil.

On hilly lands the contour cultivation should be supplemented by "balks" or "breaks," i. e., by strips of grass land separating belts or zones of plowland; and these, like the furrows, should curve with the slopes in plan and lie level in elevation. They should be carefully laid out; for, properly managed, each grass-land balk with the belt of plowland next above it will grow into a terrace without special effort, since some soil descends when stirred by plow or storm and lodges in the upper margin of the sward, raising this line until both plowland and grass land are brought into equilibrium.

Over foothills and deeply broken country ordinary agriculture should grade into silviculture and forestry, perhaps combined with horticulture and grazing; for here storm waters tend to gather into torrents, quickly passing beyond control if once allowed to form, yet easily prevented from forming by making mulch and soil so deep and spongy as to absorb not only the gentle rain, but the inch or two sometimes dropped by thunderstorm or cloudburst.

Over all mountain divides and crests below timber line forests should be retained and extended; for, as seen by settlers and happily expressed by Spanish-speaking neighbors, the mountains are the mothers of waters, and nearly every lofty range is a local "Sierra Madre," and the clearness and purity of these waters and their uniformity of flow is proportionate to the perfection of the forest cover. In earlier decades, when forests were viewed only as obstructions, silviculture was profitless; but now that the accumulated growth of a thousand years has been largely squandered, forestry is becoming a branch of agriculture no less profitable than others. It remains only to classify and assign our slopes and soils to those crops to which they are best adapted, whether these be grains or grasses or vines or trees.

In extending the principles and applications of American agriculture three steps are contemplated in the operations of the Bureau—education, individual action, and collective action.

The education need involve little more than diffusion of information on a few leading points, such as the magnitude of the annual loss due to soil erosion, the facility with which this can be checked, and the certainty that the remedy can be made not only inexpensive, but actually profitable to each person applying it. Given this information, American intelligence and enterprise may be counted on to meet the occasion.

The chief individual action required is along the lines of improved agriculture, with more intensive methods, more thoughtful conservation of soil matter and crops and their by-products, more careful attention to ground water; and here, as elsewhere, public spirit is the strongest incentive to private conduct.

In general the collective action will develop materially with the growing knowledge of communities, yet it should be aided as needed by State and Federal instrumentalities. The keynote to such action sounds in the social principle that in the long run the good of the individual is the good of the community, and in the legal principle that each so use his own as not to injure others. The direct loss through soil erosion is very great and begins on each farm and affects every community. The indirect loss is no less, perhaps greater, for the streams are fouled, water power is jeopardized, navigation is impeded or prevented, and floods are raised; and since in the end the responsibility rests with the men on whose farms the evil starts, the remedy must begin with the farming community and should be guided by the interests of the whole people.

BUREAU OF ENTOMOLOGY.

Excellent results have been gained by the work of this Bureau in the course of investigations that have for some time been under way, and by order of Congress new investigations have been begun.

THE MEXICAN COTTON BOLL WEEVIL.

This very destructive insect has shown itself more adaptable to changed conditions, and therefore more capable of extending spread, than any other insect originating in the Tropics that has ever entered United States territory. It has established itself, contrary to anticipations, north of the line of early frosts, and there will probably be no climatic barrier to its spread throughout the whole cotton belt. Its northward and eastward spread has continued since my last report, and in the early autumn of 1907 it was found to have crossed the Mississippi River and to have entered the State of Mississippi.

Under the greatly changed conditions of soil and moisture existing in the bottom lands of Louisiana and Mississippi, the insect is changing its habits.

PARASITES AND NATURAL ENEMIES.

The careful studies that have been carried on have shown, however, that as the period of the occupancy of United States territory by the boll weevil lengthens the native parasites and natural enemies are becoming accustomed to it and are attacking it with increasing effectiveness year by year. It is now known that fifteen different insects which attack the boll weevil in its immature stages are at work in the infested territory, and the number is undoubtedly increasing. This is not a matter of small importance, since during the past season in

a field near Waco, Tex., it was found that fully 40 per cent of the weevils had been killed by the combined work of several species of parasites. Practical results of parasite work are in sight, and in one experiment the mortality rate of the weevil was raised 9 per cent in two weeks by the introduction of parasites from one region to another where they were absent, or present in small numbers.

There are a number of species of weevils that attack native weeds, but which will not attack cotton. The parasites of these native weed-feeding weevils will attack the cotton boll weevil; and it has been found, after careful study of these insects and of their parasites, that where the natural food plants of the native weevils are destroyed about cotton fields at a certain time, the parasites of these weevils, in the absence of their normal food, will attack the cotton boll weevil to such an extent as very considerably to increase the mortality of the boll weevil. The native fire-ant, occurring throughout the cotton belt, is rapidly acquiring the habit of feeding upon the boll weevil. In one case, at Beeville, Tex., where the boll weevil has been known for at least twelve years, during the past year in a certain field three-fourths of the weevils in fallen squares were found to have been destroyed by this ant. Careful studies have been made and are now being made of the special conditions favorable to the increase of this ant and of the different parasites, and it seems very probable that practical results will follow.

FIELD EXPERIMENTATION.

As in preceding years, a number of large-scale experiments in different regions where the weevil problem assumes a local aspect were carried on. Nearly 1,000 acres, in lots varying from 10 to 65 acres in extent, were used in this work.

Most important results have been gained in a test of the efficacy of the fall destruction of cotton plants. In one isolated locality in Calhoun and Jackson counties, Tex., badly infested with the weevil, 410 acres, comprising all of the cotton in that vicinity and separated from other cotton plantings by about 10 miles, were cut during the first ten days of October, 1906. In Lavaca County, 30 miles away, a considerable quantity of cotton is grown at Six Mile Settlement. This cotton was not destroyed, and the fields were kept under observation as a check. The results were as follows:

In May, 1907, in the experimental fields only one weevil was found, whereas in the check fields practically all of the squares had been destroyed. In September, 1907, the cotton in the experimental fields showed a yield of about 1,000 pounds of seed cotton per acre, while in the check fields the average was about 350 pounds of seed cotton per acre, and this in spite of the fact that the soil on the check area is

much richer than that in the experimental area. The destruction of the plants in October has caused the poorer land to produce practically three times as much cotton as the richer land. The proper treatment of the fields in the experimental area resulted in an advantage to the farmers of $20 per acre.

The result is that by systematic fall destruction of cotton plants boll weevil damage can largely be averted, the reason being that by such destruction many millions of weevils in one stage or another are killed which otherwise would successfully pass the winter and infest the next year's crop.

OTHER COTTON BOLL WEEVIL WORK.

Extensive experimentation on the hibernation of the weevil was carried on; many laboratory observations and experiments were made; careful tests were made of all recommendations and suggestions that contained any element of probable success; the question of late planting versus early planting was again tested, with the result of a perfect proof of the fallacy of the late-planting idea; and a machine was devised for the destruction of the insect in fallen squares which bids fair to be of considerable value. The northward and eastward spread of the weevil was carefully watched and predictions of damage were issued from time to time. The results published in June, 1907, indicated that the damage to be expected from the boll weevil during the year would be much less than normal. This prediction was verified by the later results.

The work in cooperation with the State experiment stations was continued. One man was detailed to the Texas Experiment Station and three to the Crop Pest Commission of Louisiana, which is virtually a part of the experiment station organization in that State.

WORK ON THE GIPSY MOTH AND THE BROWN-TAIL MOTH.

During the past fiscal year work against these two destructive insects in New England was taken up under a special appropriation by Congress. Headquarters were established in Boston; a skilled agent was placed in charge; a large force of laborers was engaged, and energetic work was begun as soon as the appropriation became available. Under the terms of the appropriation the work has been directed toward preventing the further spread of the gipsy moth and the brown-tail moth, and the work has been largely concentrated upon the gipsy moth, for the reason that it can more readily be handled and spreads much more slowly, owing to the fact that the female can not fly and the species spreads largely by the accidental carriage of the caterpillars on vehicles of different sorts and by pedestrians. The brown-tail moth flies readily and its range is

much greater than that of the gipsy moth. It is easily destroyed in the winter time by the destruction of the winter nests, and an educational campaign in cooperation with the States of Maine, New Hampshire, Massachusetts, and Connecticut has been undertaken with a view of inducing property holders to accomplish the destruction of this species on their own grounds. With the gipsy moth the effort has been to destroy the insect along the main traveled roads for a distance of 100 feet or more back from the roads, thus preventing the caterpillars from spinning down from overhanging trees upon vehicles passing by. This work was started in the main centers of infestation, since these are the principal sources from which the insects are disseminated.

Such roads in 11 towns in the most thickly infested portions of Massachusetts have been cleared up, and at the present time conditions are vastly improved. In the meantime careful scouting has been carried on around the borders of the territory known to be infested, with the result that the gipsy moth has been found in many places in southern New Hampshire and at a large number of points in southwestern Maine, where it was heretofore unknown to exist. The States above mentioned and the State of Rhode Island have passed laws and have appropriated comparatively small sums of money to be used in the fight against the gipsy moth and the brown-tail moth, and conditions are such in Maine, Rhode Island, and Connecticut that the object aimed at is the extermination of the insects. The fall scouting of 1907, so far as it has as yet developed the situation, seems to show that in Maine the insect has secured a much greater foothold than was formerly supposed, but nothing has thus far developed to render extermination impossible. In New Hampshire scouting work is now going on, and since all of the colonies of the gipsy moth so far found are in orchards or along roadsides, and not in the forests, it is not improbable that extermination may be accomplished in that State. The condition as a whole is encouraging, and it is quite possible that the gipsy moth will be prevented from any further dangerous spread and at the same time can be greatly reduced in numbers. In Rhode Island, for example, the past year's work has resulted in the destruction of 95 per cent of the insects.

INTRODUCTION OF BENEFICIAL INSECTS.

PARASITES OF THE GIPSY MOTH AND THE BROWN-TAIL MOTH.

The introduction of the parasites and predatory insect enemies of the gipsy moth and the brown-tail moth referred to in my last report has been continued with great success, and it is reasonably certain that the gipsy moth, as shown in the preceding paragraph, can be

held in check by mechanical means until these imported natural enemies shall bring about a condition such as exists in Europe, where this insect only rarely appears in great numbers and then only for a single season.

In the early summer of 1907 the Chief of the Bureau of Entomology again visited parts of Europe, extending the range of his search for parasites into central and southern Russia, and by cooperation with European entomologists succeeded in introducing a much larger number than ever before of European parasites of the eggs and of the larvæ and pupæ of both the gipsy moth and the brown-tail moth. Two new species of primary parasites were introduced from Russia, and one of these proves to be a very rapid breeder and promises the best results.

These insects have been cared for in large indoor and outdoor breeding cages in the vicinity of Boston, and many thousands of specimens have been liberated in the open. There is abundant proof that several species have established themselves, and there is every reason to suppose that they will breed with greater or less rapidity. It is hoped that the results of the work of these parasites will be evident by the summer of 1909, and there is a possibility that they may be evident in 1908.

The life histories and habits of these parasites are being studied by expert assistants in the laboratory near Boston, and careful observations at the same time are being made by agents of the Department in France and in Russia. Aside from the new species imported from Russia, the most encouraging feature of the year's importations is probably the abundance of parasites of the eggs of both the gipsy moth and the brown-tail moth that have been brought to America. Six generations of one species have been followed through during the past summer.

Altogether 35 species of these beneficial insects have been imported. Of these, 14 are hymenopterous parasites, 16 are dipterous parasites, and 5 are predatory beetles. There have been colonized in the open 9 species of hymenopterous parasites, 14 of dipterous parasites, and 2 of predatory beetles, making 25 species in all. Certain evidence of the practical acclimatization of a number of these forms has been gained.

OTHER IMPORTATIONS.

Aside from continued importations of several species of European ladybirds, which are effective enemies of plant lice and other soft-bodied insects, a systematic effort has been begun to import and acclimatize the European parasites of the codling moth. The State Board of Horticulture of California has already imported one para-

site of this destructive insect and has it breeding in confinement at Sacramento, but the California organization has refused to distribute this parasite in other States except for large cash payments. The Department is therefore making the effort for the good of the whole country and will introduce not only a single parasitic species but as many as possible. Several hundred cocoons of the codling moth have already been received from different parts of Europe and are being cared for in the insectary of the Department at Washington.

What may prove to be an important egg parasite of the imported elm-leaf beetle has been discovered in France, and infested egg-masses have been sent to this country in the hope of establishing the parasite on this side of the ocean. This year's sendings were started too late, but in view of this experience it is hoped that next season this parasite may be brought over successfully.

THE SENDING OF USEFUL INSECTS ABROAD.

As indicated in previous reports, European officials have been so generous in their assistance to this country in these importations of beneficial insects that the Department has endeavored to return the courtesy wherever possible. Continued sendings of scale-insect parasites have been made during the year to Italy with promise of success.

An interesting cooperative experiment was begun during the year with the French Government, and successful sendings of a predatory wasp from the Southern States to Algeria were made. On arrival in Algeria these wasps were cared for by agents of the Pasteur Institute of Paris, acting for the French colonial government, in the effort to establish a species which will destroy the gadfly, which carries a very destructive disease of the dromedary, so important in that country as a beast of burden.

FIELD-CROP INSECTS.

During the year the investigations of the Hessian fly and the different species of jointworms have been carried on, and work has been done with the so-called green bug which injures grain in the West in the early part of the season.

HESSIAN FLY INVESTIGATIONS.

The wheat-sowing experiments have been increased during the year, and are now being carried on in eleven States, over 800 different sowings having been under constant observation this year. Exact data are being continually accumulated, showing that it is possible

to evade the most serious portion of the fall attack of the fly by seasonably late sowing in the fall, and exact dates under certain conditions for the different localities are being gradually established. These experiments, acting at the same time as demonstrations, are attracting much attention and are carefully watched by the farmers throughout the sections where the experiments are located.

An important branch of the Hessian fly work has demonstrated the possibility of the practical use of the parasites of the fly, and this is brought about by the careful study of the experimental sowings. A striking example has developed during the year. Early sown plats at Lansing, Mich., and Marion, Pa., were seriously attacked by the fly, but when examined at a later date fully 90 per cent of the flaxseeds were found to have been stung by a certain species of parasite and to contain its developing larvæ. At this time a field of wheat near Sharpsburg, Md., was found to be infested by the fly and examination indicated the absence of parasites. On April 8 some thousands of the parasitized flaxseeds from Pennsylvania were brought to Maryland and placed in the field. On July 8 an examination of the Maryland field showed that the parasites had developed so rapidly as to bring about an almost total destruction of the fly.

INVESTIGATIONS OF THE SO-CALLED GREEN BUG.

A destructive outbreak of this insect was carefully studied by several expert assistants. It began in Texas in January, and then consecutively in the States to the North, until it finally appeared across the Canadian border. Many remedies were tried, and a large-scale experiment was carried out in the carriage of early developing parasites from the South to more northern localities, liberating them in infested fields. Important results were obtained, and it was apparently shown that under the conditions under which the experiments were made this year there is little or nothing to be gained by such transportation of parasites, since they develop almost simultaneously in northern fields into which southern parasites have not been introduced. Further experimentation of this kind, however, must be carried out before exact conclusions can be announced.

JOINTWORMS AND OTHER GRAIN INSECTS.

Experimental work with the wheat jointworm and the timothy jointworm has been continued, and it has been shown that a proper rotation of crops will practically prevent damage by both insects. Further investigations have been made on the seed-corn ground beetle and the corn-root aphis and a number of other insects belonging to this group.

WHITE FLY INVESTIGATIONS.

By order of Congress, and under a special appropriation in response to strong demands from the Florida citrus-fruit growers, an investigation was begun on the white fly, an insect which does great damage to orange and lemon groves. A special agent with ample assistance was located in Florida, and life history studies have been made, experiments carried on in the introduction of parasitic insects, and in the encouragement of fungous diseases, and also in the control of the insect by the use of insecticides and gases. Much information of distinct value has resulted. Parasites of native insects of the same family have been brought from different parts of the country, and some results have been obtained which indicate that in the more humid portions of Florida the fungous diseases of the insect may be encouraged. The thorough investigation of the use of liquid sprays has progressed, and experiments in the use of hydrocyanic-acid gas indicate that under favorable conditions—that is, isolation from other infested groves, or where concerted action can be had—fumigation is much more economical than spraying and much more certain in its results than reliance on natural enemies.

INSECTS AFFECTING TOBACCO.

In the bill making appropriations for the Department for the present fiscal year a clause was inserted providing for investigation of insects injurious to tobacco in the dark tobacco belt of Tennessee and Kentucky. An expert assistant was sent to the region late in May, 1907, to make a preliminary examination of the field. Studies were made of the tobacco flea beetle, which seems to have been especially injurious this year, of cutworms, of plant lice, and of a few other species. Experimental plats at two important points were arranged for and cooperation with the Tennessee and Kentucky experiment stations was also arranged. A permanent special agent was placed in the region in question, and his work is now well under way.

INSECTS DAMAGING DECIDUOUS FRUIT TREES.

In addition to the continuation of investigations already in progress, an important new project has been taken up, namely, the study of the pear thrips and other deciduous fruit insects in portions of California. A station has been established at San Jose, an expert has been placed in charge, and the destructive pear thrips is being studied with the greatest care.

The plan of maintaining field stations in parts of the country devoted to the growing of deciduous fruits on a large scale has

proved to be an excellent one, and in this way it has become possible to thoroughly study the insects being investigated under perfectly normal conditions and to conduct tests of remedies on a commercial scale. This work and the tests of insecticides is carried out according to a uniform plan, and thus shows variations in the life and habits of a given species in different parts of the country and what changes should be made in the use of remedies.

To the work in Pennsylvania has been added an investigation of the destructive grape rootworm. Demonstration spraying in the control of the codling moth and apple disease in cooperation with the Bureau of Plant Industry has been carried on at several points, and the work upon the plum curculio and the peach tree-borer, as well as that upon the San Jose scale, especially in the investigation of different washes, has been continued.

BEE CULTURE.

The chief problem taken up in this work was the investigation of the brood diseases of bees, and a bulletin on this subject was prepared and published. Careful bacteriological work has been done on these diseases and a number of obscure points have been cleared up.

Work on bee paralysis, a disease of adult bees, has been carried on by an agent in California. This is a most obscure disease, and no evidence of the influence of a micro-organism has as yet been found.

Distribution of breeding material of the various known races of bees has been carried on, and work on experimentation with honey-producing plants has also been continued.

An interesting series of tests has been begun as to the comparative value of the various races of bees in fertilizing red clover.

SILK CULTURE.

No changes have been made in the methods that have been followed for some years past in the effort to continue the production of silk in the United States. Eighty-five ounces of tested eggs were imported from Italy and distributed to 343 applicants in the spring. About 11,000 seedlings of the best white mulberry were also distributed. Cocoons were purchased from American growers at a rate varying from 90 cents to $1.15 per dry pound, and these cocoons were reeled at the Department. The reeled silk on hand was sold during the year at $4 a pound, bringing in a return of $1,012, which was deposited with the Treasury Department in compliance with the regulations.

INSECTS INJURIOUS TO VEGETABLE CROPS.

In the course of the year the investigations of insects of this class have been continued with a larger force than ever before, and some excellent results have been obtained. For example, in a series of cooperative investigations made between the Bureau and the Texas Agricultural Experiment Station on the melon aphis, great success has been obtained in the elaboration of remedial measures and in the demonstration of their efficiency. Especial attention has been paid to insects injurious to truck crops in the South, the region from which the early vegetables are sent to the northern markets.

Investigations of sugar-beet insects have been continued, and a full report upon the beet leaf-hopper, which has been very destructive in Utah and Idaho in recent years, is practically completed.

INSECTS INJURIOUS TO FORESTS.

In this direction very satisfactory progress has been made both in acquiring and diffusing information of practical value to the forest interests of the country. Especial work has been done upon insects that prevent forest reproduction, and those injurious to forest products, both crude and finished. Damage done by powder post beetles to finished hardwood material has been investigated with the result that successful methods of control have been ascertained. Studies have been made of beneficial forest insects looking toward their practical utilization. The studies of the damage by bark beetles to coniferous trees have been continued, and recommendations of the Bureau have been adopted with excellent results.

INSECTS WHICH CARRY DISEASE TO MAN AND DOMESTIC ANIMALS.

The work of the Bureau on the subject of mosquitoes has been continued, and a complete account of the mosquitoes of North America, including some consideration of their relations to disease, is nearly finished.

The investigation of the life history of the Texas cattle tick and other injurious ticks which may be concerned in the transmission of disease has been continued in cooperation with different State entomologists, and many important points having a direct bearing upon methods of control have been ascertained. A true parasite of one of the ticks has been found which offers hope that natural methods of decreasing the abundance of ticks may yet be learned.

OTHER INVESTIGATIONS.

Elaborate work on the destructive group of scale insects has been carried on through the year. Insects injurious to stored products

have been further studied. Elaborate tests of different insecticides have been made, and radical inspections have been made of all of the plant material introduced by the Department and sent out, so that the danger of spreading insect pests in this way is practically removed. Investigations of the insects affecting the pecan in the South have been begun.

BUREAU OF BIOLOGICAL SURVEY.

Practically all the investigations under way in the Bureau of Biological Survey at the time of the presentation of my last report have been continued and additional and important lines of work have been begun.

ECONOMIC VALUE OF BIRDS.

The education of the public as to the value of birds generally and the part they play in the economy of nature is felt to be an important part of the duties of the Survey. School children especially need enlightenment, both as to the value of birds and as to the duty of the citizen toward them. During the last year circulars have been issued with this important educational end in view.

ECONOMIC INVESTIGATIONS.

THE BOLL WEEVIL.

Work in relation to the ravages of the boll weevil was continued in Texas and Louisiana with gratifying results. Several additional birds were found to feed on the weevil, bringing the number of species now known to prey on it up to 43. A report detailing the results of the season's observations has been published, and it is hoped that its wide dissemination in the cotton States will have two important results: (1) The enactment of necessary protective legislation for several species of birds not now protected; (2) the enlightenment of all classes of citizens in the cotton States as to the important part certain birds play in limiting the ravages of the pest, and also the enlistment of their cooperation in protecting and in increasing the numbers of the birds that destroy the weevil. That the latter is entirely practicable can not be doubted, at least in the case of swallows, which are among the most persistent enemies of the weevil. While these useful birds are under protection of law in the Southern States as elsewhere, it has been ascertained that in certain districts their nests are broken up and the birds driven away or destroyed, under the mistaken idea that they harbor insects obnoxious to man. Such is not the case, and it is believed that if wide publicity is given to the facts the birds, instead of being persecuted, will be encouraged,

as they should be, to build in every available site. A substantial increase of numbers would enable them to wage more effective war against many injurious insects, including the worst offender of all, the boll weevil.

BIRDS IN RELATION TO FRUIT RAISING.

For several years work has been conducted in the fruit regions of California to determine the exact status of birds in their relation to this great and growing industry. The vicinity of orchards is known to be a favorite home of birds, but by no means all the birds that nest in and about orchards are attracted by the fruit. On the contrary, numerous species choose orchards as their home, or as their hunting grounds, because of the multitude of insects which infest fruit and fruit trees. Careful examinations of the stomachs of orchard birds show that by the destruction of injurious insects most of the birds that eat fruit more than compensate for the damage they do. The moderate amount of fruit consumed by such species may properly be looked upon as pay for services rendered, and it may be added that the service is cheaply bought. In the case of certain species which are harmful to the fruit growers' interests remedial methods are suggested.

SCALE-EATING BIRDS.

Special investigations have been made to determine the extent to which birds prey on scale insects. These dangerous pests are so small and so sedentary that they have been generally supposed to be overlooked by birds. Such proves to be by no means the case, and no fewer than 57 species of birds have been ascertained to feed on scales. Moreover, certain birds, the grosbeak, for instance, appears to have a special fondness for them and to hunt them assiduously.

TRAFFIC IN CAGE BIRDS.

The fact that 300,000 cage birds are yearly imported into this country and that the number is constantly increasing will surprise many. By far the greater number of these importations are canaries, or other cage birds. There seems to be no reason why most if not all the cage birds required in this country should not be raised here. The industry is very profitable in Germany and elsewhere abroad, where it is carried on, not in a wholesale way, but by the women and children of individual families who, with comparatively little labor and trouble, add an interesting occupation to their ordinary household duties and secure satisfactory returns in cash. The mountain regions of the Southern States, particularly, would seem to furnish almost ideal conditions for such an industry, which, besides being lucrative, possesses the added advantage of substituting domestic

birds for such wild species as the mocking bird, cardinal, and nonpareil, whose value to agriculture is too great to make it desirable to confine them in cages.

DUCKS AND SHORE BIRDS.

In the past one of the important food sources of the United States was its game, particularly its ducks, geese, and shore birds, thousands of which found their way to the markets of all our large cities to be used for food by rich and poor. Unfortunately the natural supply of these birds was not wisely husbanded with an eye to the future, but, as in the case of the buffalo and wild pigeon, was mercilessly pursued till at the present time not a few species are threatened with speedy extinction. The subject is important, and it is obvious that if the more desirable species of ducks and geese are to be preserved for the future, additional legislation is needed. The essential data to serve as a basis for legislative action are a knowledge of the food supply and of the pairing times of the several species of ducks, geese, and waders; and of the routes they pursue in migration. These subjects are now being carefully investigated.

ECONOMIC MAMMALOGY.

The problems connected with this branch of the work are many and important. While in some sections of the country the devices employed to reduce the number of noxious mammals, especially the smaller rodents, have proved successful, in many others the reverse is the case. Traps, poisons, and gases, when intelligently employed, are efficient, but they often stop short of serving the desired end owing to want of cooperation. They must be used at the proper seasons, must be employed persistently, and, to secure the best results, should be employed simultaneously by all the farmers over a wide extent of country. In many regions, unfortunately, cultivated areas alternate with strips of wild and unimproved land, so that the latter form nurseries from which adjoining farms are populated anew after the number of rodents has been reduced to harmless proportions. Thus warfare against mammals is ceaseless and expensive and constitutes a heavy tax upon agriculture.

It is with a view to the discovery of more effective and cheaper methods of destroying rodents that experiments with contagious diseases have been continued in cooperation with the Bureau of Animal Industry. A very important field for this work is among the small ground squirrels of the Northwest, where these animals annually destroy vast quantities of grain. Laboratory experiments have yielded promising results, and work along this line will be continued with the hope of securing a virus which can be utilized in reducing the number of rodent pests throughout the affected area.

THE RABBIT PEST.

Complaints of damages to orchards and various other crops by rabbits continue to be received. Experiments were continued during the past year with a view to the discovery of a protective wash for fruit trees, and excellent results were obtained with the lime-and-sulphur wash, well known as a remedy for the San Jose scale. The wash can be made in quantities very cheaply, and it seems to protect fruit and other trees perfectly from the attacks of both rabbits and mice. It is also durable in effects, one liberal application lasting all winter. Should further experiments confirm the efficacy of this wash as a protection for trees against the attacks of small rodents, an important problem will have been solved, as the annual destruction of orchard trees by rabbits and mice reaches large proportions.

HOUSE RATS.

No one of our wild mammals, possibly not all combined, does so much damage as the common rat. Many experiments have been made to discover satisfactory methods of checking the depredations of these animals and of reducing their numbers. A bulletin setting forth the most approved methods known was issued during the year with the expectation that it will materially aid in the protection of property from the attacks of these pests. Meanwhile experiments with bacterial diseases are being continued for the purpose of discovering a safe and effective virus, fatal to these rodents and yet harmless to domesticated animals.

FIELD MICE.

Though small, field mice are so generally distributed over the United States and so numerous in certain regions that they often do great damage in gardens, meadows, nurseries, and orchards, where they attack fruit trees and crops. Alfalfa is particularly relished by these rodents, and, as it is very nutritious, when once they have invaded a patch they increase enormously. As in summer they attack the foliage and in winter the roots, if unchecked they soon destroy whole fields and render fresh planting necessary. They thus possess considerable economic importance. A careful study has been made of their habits and such methods of prevention suggested as have been found most efficacious are set forth in a bulletin which is now being widely distributed.

WOLVES.

Methods of destroying wolves that prey upon stock on the western ranges have been carefully studied and two reports on the subject were issued last year—one, in cooperation with the Forest Service,

in relation to the destruction of stock on the western ranges; the other in connection with the destruction of deer in Michigan and Wisconsin. The adoption by stockmen of the methods recommended—especially killing the young in the breeding dens—has already resulted in a material reduction in the number of wolves and a corresponding saving of stock and game.

GEOGRAPHIC DISTRIBUTION—LIFE ZONES AND CROP ZONES.

The essential purpose of this work is to furnish the practical farmer a guide to the crops best fitted for any given area. From a study of our native fauna and flora it has been found that the country is divided into zones or belts, each characterized by certain conditions of temperature and by the presence of particular species of mammals, birds, reptiles, and plants. Each of these primary life belts covers an extensive transcontinental area, which in turn is subdivided into minor areas. It has been found that crops adapted to one part of an area thrive under similar conditions in other parts and will not thrive in areas having materially different conditions. By means of this knowledge, in connection with the zone maps, a vast deal of costly experimentation is saved. Life-zone maps of the several States are now in course of preparation, to be followed by lists of crops and fruits best adapted for cultivation in the different areas. The great demand for the generalized map and report already published and for the more detailed maps not yet finished is an earnest of the practical importance of this work.

Field work in several States, as California, Colorado, and New Mexico, is now being carried on with a view to early publication of results. Considerable work has been done in other States, and it is hoped that sufficient funds will be forthcoming to permit this work to be completed as rapidly as possible, especially in the States where large irrigation projects are expected to make available immense tracts of hitherto nonagricultural land.

GAME PROTECTION AND INTRODUCTION.

ENTRY OF FOREIGN BIRDS AND MAMMALS.

The act of Congress of May 25, 1900, prohibiting the entry into the United States of the mongoose, English sparrow, flying fox, and starling has now become so well known that for the past two years none of these pests has been offered for entry, nor has constant vigilance disclosed any attempt to introduce them surreptitiously.

The importance of a check upon the possible introduction of pests into the United States grows with the growth of the trade in cage birds, which is increasing very rapidly. During the year, besides 708 mammals, 408,532 birds were imported under permit, an increase

of 27 per cent over those of the preceding year and 51 per cent over those imported in the year ending June 30, 1905. Of this large number, 351,407 were canaries. Nearly all were entered at New York and Philadelphia, and all but a comparatively small number were subjected to careful inspection by the Department's representatives at those ports. In addition to its value as a means of preventing the introduction of injurious species, the service presents features of more than ordinary interest in revealing the extent and character of a trade concerning which little has been generally known.

Its usefulness further appears in the fact that it keeps the Department informed of the importation of foreign game birds for the purpose of stocking American covers. Our own game birds are constantly diminishing in abundance, and the practice of introducing foreign birds as a substitute grows in favor. Many species, serving both for food and sport, have already been more or less firmly established in various parts of the country. During the year Illinois imported more than 1,000 European partridges, and Kansas imported about 2,000 English pheasants. Capercailzie and black game of northern Europe, the former of which is nearly as large as wild turkey, have been imported successfully for liberation at various points, notably on Grand Island, Michigan, and in the Algonquin Park, Ontario.

The experiment of stocking covers by means of imported eggs of game birds also is apparently meeting with favor. Under the act of June 7, 1902, every such consignment requires a permit from the Department. More than 5,900 eggs were imported during the year. In number this was but a slight increase over those brought in in 1906, but the fact that they were imported in 39 different consignments, as against 5 in the preceding year, shows a much more widespread interest.

INTERSTATE COMMERCE IN GAME.

The most important feature in the suppression of illegal interstate commerce in game was the arrest of two noted tusk hunters, and the confiscation of a large quantity of hides, horns, and teeth of elk they had secured in the Yellowstone Park and vicinity. The men involved in this particular transaction were tried for a violation of the Lacey Act in shipping their plunder from Idaho to California. They pleaded guilty and were promptly fined $200, the minimum penalty under the Lacey Act. It is greatly to be regretted that the demand for the heads, horns, and especially the tusks of elk, should threaten the extinction within our territory of this noble game animal, and every effort should be made by National and State authorities to protect the few remaining head. The high price paid for trophies, especially

the teeth, is an incentive to pursue the animals. The practice of hunting elk has been conducted with disregard of the Federal and State laws, and has been very destructive.

Attention is called again to the importance of additional supervisors to be stationed at central points to represent the Department in its efforts to abolish unlawful interstate commerce in game. It is impossible for the Department to secure adequate enforcement of the Lacey Act without increase of its force. Local conditions must be studied, evidence must be secured, and it is often essential, as with other branches of the Government service, that the Department be represented at the trials of important offenders. The cost of such additional force would be slight and the benefit very great.

BIRD RESERVATIONS.

No new reservations were established during the year, but the seven already created were maintained under careful supervision. Some poaching was reported by the warden of Stump Lake Reservation, in North Dakota, but as three of the poachers were arrested, promptly convicted, and fined $25 each, the example will probably have a deterrent influence.

PUBLICATION OF INFORMATION CONCERNING GAME.

One of the most serviceable duties of the section of game preservation consists of informing the public of existing laws relating to protection and hunting of game and special features connected therewith. Within the last twenty years game laws have become so numerous and complicated, as compared with the simple provisions of former times, that it is exceedingly difficult, without some such central source of information, for the sportsman or dealer in game to acquaint himself with the various requirements of State laws. Such information not only interests and benefits the general public, but frequently serves as a basis for State legislation. Perhaps the most important publication prepared by this office during the year was one treating of the methods and machinery employed in the enforcement of game laws.

PRESERVATION OF GAME IN ALASKA.

During the last session of Congress a bill was introduced placing the duty of issuing permits for the export of trophies and specimens from Alaska with the governor of the Territory, instead of with the Department, and providing for the issue of licenses. The bill, however, failed of passage, and for the present the Department will continue its conservative policy in regard to the issue of export permits. I am impelled to renew my recommendation that Congress relieve the

Department of the duty of enforcing the Alaska game law. The present law is unsatisfactory, both to the residents of Alaska and to this Department.

COOPERATIVE WORK.

Much attention is given to cooperative work, chiefly in connection with the establishment and maintenance of efficient game and bird protection in the various States. Special aid was given to Alabama, California, Connecticut, Delaware, New Jersey, New York, Pennsylvania, Tennessee, Texas, Vermont, Virginia, and Wisconsin. Requests for such aid are of increasing frequency, but are complied with so far as possible. They involve chiefly explanations to legislatures, or legislative committees, of certain special features of game protection, and of assistance in cases arising from violations of game laws.

DIVISION OF ACCOUNTS AND DISBURSEMENTS.

To appreciate properly the present importance of this Division and the rapidity with which its responsibilities are increasing it is only necessary to consider the growth of the Department as a whole, as shown by the appropriations for agricultural investigations and related purposes since its inception in 1839. In that year $1,000 was set aside by Congress "for the purpose of collecting and distributing seeds, prosecuting agricultural investigations, and procuring agricultural statistics." In 1849 the appropriation had increased to $3,500 and in 1859 to $60,000. In 1862 the importance and value of the work, until then prosecuted under the direction of the Commissioner of Patents, had secured such recognition that a department headed by an independent Commissioner was created for its continuance. In 1869 the agricultural appropriation amounted to $172,593, in 1879 to $206,400, and in 1889 to $1,034,480, by which time the administration of the financial affairs of the Department had developed such importance that a separate division became necessary to insure proper disbursement of the funds set aside by Congress for the needs of the Department. In 1899 the annual appropriation had increased to $2,829,702, but during the past ten years the growth of the Department has been rapid and the benefits to the public have increased correspondingly. The regular appropriation bills of the Department for ordinary and routine expenses from 1903 to 1908, inclusive, show an average annual percentage of increase of 12.9.

The amount estimated for the fiscal year ending June 30, 1909, in the regular appropriation bill is $10,666,351, which includes $720,000 for agricultural experiment stations. This is an apparent increase of $1,459,061, or 15.8 per cent; but, taking into consideration the loss of revenues derived by the Forest Service from the sales of timber, etc. (estimated at $1,500,000 annually), which heretofore have been

used for maintenance of the reserves, but which, beginning on July 1, 1908, are required by law to be deposited in the Treasury to miscellaneous receipts, it is in reality no increase. In addition there will be a permanent appropriation of $3,000,000 for meat inspection, and an item of $550,000 in the sundry civil bill for printing and binding for this Department, to be done under the Public Printer, making a grand total of $14,216,351.

The proper disbursement of the great sums now being appropriated annually for the use of the Department at the present time involves the careful scrutiny, administrative examination, and audit of more than 50,000 accounts annually and the issue of about 75,000 checks. This duty, which is performed by the Division of Accounts and Disbursements, insures a conformity of the expenditures to the requirements of the appropriation acts and the regulations of the Treasury Department, in addition to which absolute economy of disbursement is secured by the departmental system of project filing which was developed over two years ago for the purpose of insuring judicious and careful expenditure and of rendering any duplication of work in the several bureaus absolutely impossible. In the operation of this system each chief of Bureau files a detailed statement every six months regarding each project in operation or contemplated in his particular Bureau. With these statements before him, the head of the Department is enabled to coordinate and direct the work of the several Bureaus to the greatest possible advantage. Over 1,300 projects are on file, and no new projects are embarked upon without being first brought to the attention of the head of the Department in the manner described. It may be remarked in this connection that the system of project filing here outlined is peculiar to and entirely original with the Department of Agriculture.

During the fiscal year ending June 30, 1907, the Congressional Committee on Expenditures in the Department of Agriculture carefully investigated the expenditures for the preceding fiscal year. In the course of this investigation all the higher officials of the Department appeared before the committee and under oath explained in detail the character and object of the various lines of work being prosecuted by the Department. It is gratifying to state that as a result of the examination every penny of the agricultural appropriations was properly accounted for, the work and discipline of the Department received high commendation, and it was shown that the annual value of the Department of Agriculture to the general public at the present time is nearly a quarter of a billion dollars. As the annual appropriation for the Department is about $14,000,000, it will be seen that this is a return of about $16.50 for every dollar appropriated by Congress.

For the prosecution of the various activities of the Department of Agriculture during the year ending June 30, 1907, including the permanent appropriation of $3,000,000 for meat inspection and other special appropriations, Congress appropriated the sum of $11,557,691.36, this amount being $4,382,001.36 in excess of that similarly appropriated for the preceding year. The disbursements of the Department during the fiscal year 1907 amounted to $8,586,209.23, and the greater part of the balance of $2,971,482.13 will be required for the settlement of outstanding liabilities.

The amount paid for rent of buildings in the District of Columbia in the several branches of the Department was $50,148.96.

All accounts for the fiscal year 1905 having been settled, the unexpended balance of appropriations for that year, amounting to $74,336, was covered into the Treasury on June 30, 1907. The account for the fiscal year 1906 is still open.

DIVISION OF PUBLICATIONS.

The results of the investigations conducted by the Department are made known and become available for the use of the people by means of publications, of which 1,415 were issued during the year, 596 being new and 819 reprints. These publications comprised 52,363 printed pages and the total number of copies aggregated 16,746,910, an increase of 3,258,889 copies over last year.

The publication work of the Department has assumed such magnitude that only by the most careful editorial supervision and by the enforcement of the most rigid economy in the printing and by the exercise of constant discretion in the distribution of the documents has it been possible to accomplish the results attained with the present appropriation. It has become absolutely necessary to reduce the editions of the scientific and technical publications to sufficient numbers to supply only restricted lists of cooperators, educational institutions, experiment stations, and libraries, and to refer miscellaneous applicants to the Superintendent of Documents, who, under a wise provision of law, is authorized to reprint our publications and sell the same at a nominal price so long as there is a demand for them. The fact that last year 71,764 copies of various publications of this Department were sold at an aggregate price of $10,885.20 is indisputable evidence of the willingness of applicants to purchase publications in which they are interested and thus to contribute toward the support of the publication work of the Department. If the publications could be placed on sale at the post-offices throughout the United States, and thus made easily procurable, I feel confident that the people would buy them. In this way the wide dissemination of the practical information they contain would be insured, which is not possible under the system now in vogue and with the funds available for printing and binding.

FARMERS' BULLETINS.

Farmers' Bulletins continue to be the most popular publications of the Department. Forty-two new bulletins were issued during the year, the number of copies printed being 1,100,000, while 443 reprints of bulletins were made in editions aggregating 5,369,000, the total number of Farmers' Bulletins printed in the year being 6,439,000 copies, of which 3,484,713 were distributed upon the order of Senators, Representatives, and Delegates in Congress. The fund appropriated for the preparation and printing of these bulletins remains at $98,750, which is inadequate to print the number required, and I have asked for $125,000 for next year, with the view to increasing the number allotted to each Senator, Representative, and Delegate in Congress to 15,000 copies and to enable the Department to supply the increasing demand for these publications. The total number of Farmers' Bulletins printed and distributed since the series was created in 1889 is 55,125,000, of which 37,400,161 have been distributed by Members of Congress.

It would be difficult to estimate the increased value of the crops of this country resulting from the adoption of the improved methods of farming described in these bulletins, which have been distributed in such large numbers to every section of the United States.

PUBLICATIONS SPECIFICALLY AUTHORIZED BY LAW.

There are nine publications of this Department the annual printing of which is specifically authorized by law. Under the provisions of Joint Resolution No. 14, approved March 30, 1906, it is permissible to order any part of the edition instead of the total number of copies specified. The Department has availed itself of this provision, and instead of printing the greatest number allowable, which was 68,000 copies, only 46,100 were ordered, thus effecting a saving of $15,000.

WEIGHING THE MAIL.

In accordance with a provision of the act making appropriations for the Post-Office Department for the fiscal year ending June 30, 1907, the Division of Publications weighed carefully the mail forwarded through the post-office under penalty envelopes during the first half of the fiscal year, the results of which are interesting, inasmuch as the principal distribution of the publications of the Department is made through this Division. The record shows that during that period 3,698,725 packages, weighing 622,988 pounds, which would require at ordinary postage rates $66,450 to provide stamps, were delivered to the city post-office. An accurate account of the entire year's distribution can not be obtained by doubling these figures, as the demands for the Department's publications during the last half of the calendar year are not so great as during the winter

and spring months. Therefore it is a fair estimate to place the weight of the domestic mail forwarded by the Division of Publications at more than 1,500,000 pounds. In addition, there were mailed to foreign countries, prepaid by postage, 44,426 packages, weighing 14,426 pounds 13 ounces, at a total cost for postage of $1,474.98; and 134 packages, weighing 508 pounds 4 ounces, were forwarded through the Bureau of International Exchange, Smithsonian Institution, as the weight of each package was in excess of the limitations imposed by the foreign countries to which they were mailed. Furthermore, there were forwarded to the Dominion of Canada, Mexico, and Cuba, under the frank, 15,909 packages, weighing 3,972 pounds. Many of the publications thus forwarded were sent by registered mail. A card index is kept of the distribution of the more important bulletins and reports, and a careful record is kept of every publication distributed, the Division of Publications being charged with this distribution under the provisions of the act of January 12, 1895.

TO FACILITATE THE REPRINTING OF OUR PUBLICATIONS BY THE AGRICULTURAL EXPERIMENT STATIONS.

There is a growing desire on the part of the agricultural experiment stations to distribute publications of this Department, especially those that relate to subjects in the investigation of which there has been cooperative work. Unfortunately the Department fund is insufficient to permit the printing of the copies desired for distribution by the stations. I strongly recommend some modification of the law of January 12, 1895, relating to the public printing and binding, which would authorize the Public Printer to sell at reasonable prices to the directors of the agricultural experiment stations electrotype plates of the publications of the Department. This would enable the stations to reprint at small expense any publication of this Department, thus insuring a wider dissemination of the information contained in our publications than is possible with the present appropriation for printing.

BUREAU OF STATISTICS.

GROWTH AND DEVELOPMENT OF CROP STATISTICS.

The first provision for the collection of agricultural statistics by the Department of Agriculture was made by Congress in 1863. At that time the United States was entering upon a period of rapid development of agricultural and commercial resources, and there was felt by different branches of business a necessity for the collection and dissemination of additional information regarding the crops of the country.

The requirements of foreign markets brings about dependence upon the United States for agricultural products. To meet these demands at home and abroad is the province of American agriculture. The manufacturer, the merchant, the skilled operative in the factory, to as great an extent as the farmer, feels deeply interested in the reports of the condition and progress of an agriculture upon which all are dependent.

Statistical information concerning crop production and live stock that is collected by the slow and exact methods of a census is generally not given to the public until after the crops enumerated are harvested and marketed and the immediate interest in it has passed away. Price movements of agricultural products are primarily governed by the law of supply and demand, and so a knowledge as early as practicable of the supply is essential. Those who produce and those who consume have interests as well as the dealer who operates between them. The mutual interests of agriculture, manufacture, and commerce demand that there should be published at brief intervals during the crop season reliable information on the condition, acreage, production, and value of the principal crops.

The life of commerce being the exchange of the products of agriculture and manufacture among producers and consumers, commerce prospers in proportion as the farmer prospers and the operative thrives. Some individuals, however, do not regard the common welfare, and injurious speculations occur when ignorance of the condition of our crops prevails. At such times the farmer does not obtain just prices, the consumer is not benefited, and business is injuriously affected. The consequences of false reports concerning the prospective yield or condition of the cotton crop alone might be very injurious. If there were no adequate Government crop-reporting service and the cotton crop should receive the full force of the reports of harmful speculators, for every cent per pound that prices were unfairly depressed the growers would lose 60 million dollars or more; if the prices were improperly increased, the manufacturers and allied interests would be affected to a proportionate degree. All interests, therefore, demand that the true condition of crops should be made known promptly.

It was to remedy these evils and to subserve and protect the interests above noted that Congress has provided for issuing monthly crop reports. From an allotment of a few thousand dollars each year the crop-reporting service has been evolved, perfected, and enlarged into the Bureau of Statistics. The total cost of such service from its beginning down to date has been about 3½ million dollars.

The first enactment authorizing the collection of agricultural statistics by the Department of Agriculture was the act establishing the Department, passed May 15, 1862, " the general design and duties

of which shall be to acquire and to diffuse among the people of the United States information on subjects connected with agriculture, in the most general and comprehensive sense of that word."

METHODS OF CROP REPORTING.

The general plan of the crop-reporting service has not undergone material changes during the past year. Efforts have been devoted to perfecting and improving many details of the organization.

The Bureau of Statistics issues each month detailed reports relating to agricultural conditions throughout the United States, the data upon which these facts are based being obtained through a special field service, a corps of State statistical agents, and a large body of voluntary correspondents composed of the following classes: County correspondents, township correspondents, individual farmers, and special cotton correspondents.

The special field service is composed of seventeen traveling agents, who are especially qualified by statistical training and practical knowledge of crops, each assigned to report for a given group of States. They systematically travel over the districts assigned to them, carefully noting the development of each crop, keeping in touch with best-informed opinion, and reporting monthly and at such other times as are required.

There are forty-five State statistical agents, each located in a different State. Each of these reports for his State as a unit, and maintains a corps of correspondents entirely independent of those reporting directly to the Department at Washington. These State statistical correspondents report each month direct to the State agent on schedules furnished them. These are then tabulated and weighted according to the relative product or area of the given crop in each county represented, and summarized by the State agent, who coordinates and analyzes them in the light of knowledge of conditions derived from personal observation and other sources, and prepares his monthly and other written and telegraphic reports to the Department.

There are approximately 2,800 counties of agricultural importance in the United States. In each of these counties the Department has a principal county correspondent, who maintains an organization of several assistants. These county correspondents are selected with special reference to their qualifications, and constitute an efficient branch of the crop-reporting service. They make the county the geographical unit of their reports, and, after obtaining data each month from their assistants and supplementing these with information obtained from their own observation and knowledge, report directly to the Department at Washington.

In the township and voting precincts of the United States in which farming operations are extensively carried on the Department has

township correspondents who make the township or precinct the basis of reports, which they also send to the Bureau of Statistics each month.

Finally, at the end of the growing season a large number of individual farmers and planters report on the results of their own individual farming operations during the year, and valuable data are also secured from 30,000 mills and elevators.

With regard to cotton, all the information secured from the foregoing sources is supplemented by that furnished by special cotton correspondents, embracing a large number of persons intimately concerned in the cotton industry, and, in addition, inquiries in relation to acreage and yield per acre of cotton are addressed to the list of cotton ginners through the courtesy of the Bureau of the Census.

SCOPE OF CROP REPORTS.

Eleven monthly crop reports on the principal crops are received yearly from each of the special field agents, county correspondents, State statistical agents, and township correspondents, and one report relating to the acreage and production of general crops is received during the year from individual farmers.

Six special cotton reports are received during the growing season from the special field agents, from the county correspondents, from the State statistical agents, and from township correspondents, and the first and last of these reports are supplemented by returns from individual farmers, special correspondents, and cotton ginners.

TRANSMISSION OF REPORTS TO BUREAU BY CORRESPONDENTS.

Previous to the preparation and issuance of the Bureau's reports each month, the several classes of correspondents send their reports separately and independently to the Department at Washington.

In order to prevent any possible access to reports which relate to speculative crops, and to render it absolutely impossible for premature information to be derived from them, all of the reports from the State statistical agents, as well as those of the special field agents relating thereto, are sent to the Secretary of Agriculture. By an agreement with the postal authorities these envelopes are delivered to the Secretary of Agriculture in sealed mail pouches. These pouches are opened only by the Secretary or Assistant Secretary, and the reports, with seals unbroken, immediately placed in the safe in the Secretary's office, where they remain sealed and guarded until the morning of the day on which the reports are issued, when they are delivered to the Statistician by the Secretary or the Assistant Secretary. Reports from special field agents and State statistical agents residing at points more than 500 miles from Washington are sent by

telegraph in cipher. Those in regard to speculative crops are addressed to the Secretary of Agriculture, by whom they are placed in the safe in his office.

Reports from the State statistical agents and special field service in relation to nonspeculative crops are sent to the Bureau of Statistics and are kept securely in a safe until the data contained in them are used by the Statistician in compiling estimates regarding the crops to which they relate. The reports from the county correspondents, township correspondents, and other voluntary agents are sent to the Chief of the Bureau of Statistics by mail in sealed envelopes.

PREPARATION OF REPORTS.

The plan of placing the final preparation of the reports in a crop-reporting board has been continued during the past year, and after two full years of trial it has been demonstrated that it is a satisfactory method. It relieves one man of the strain and responsibility and secures the benefits of consultation and the consensus of judgment of men who have been on the ground.

The crop-reporting board is composed of the Chief of the Bureau as chairman and four other members whose services are brought into requisition each crop-reporting day from among the statisticians and officials of the Bureau and the special field and State statistical agents who are called to Washington for the purpose.

The personnel of the board is changed each month. The meetings are held in the office of the Statistician, which is kept locked during its session, no one being allowed to enter or leave the room or the Bureau, telephones being disconnected.

When the board has assembled, reports and telegrams regarding speculative crops from State and field agents, which have been placed unopened in a safe in the office of the Secretary of Agriculture, are delivered by the Secretary, opened, and tabulated, and the reports, by States, from the several classes of correspondents and agents relating to all crops dealt with are brought together in convenient parallel columns on final tabulation slips. The board is thus provided with several separate estimates covering each State and each separate crop, made independently by the respective classes of correspondents and agents of the Bureau, each reporting for a territory or geographical unit with which he is thoroughly familiar.

Abstracts of the weather condition reports in relation to the different crops, by States, are also prepared from the weekly bulletins of the Weather Bureau. With all these data before the board, each individual member computes independently, on a separate sheet or final computation slip, his own estimate of the acreage, condition, or yield of each crop, or of the number, condition, etc., of farm animals for each State separately. These results are then compared and discussed

by the board under the supervision of the chairman, and the final figures for each State are decided upon. It has been interesting to note how often the reports of the different classes of correspondents and agents are very nearly identical, and how closely the figures arrived at independently by the individual members of the board agree. The estimates by States as finally determined by the board are weighted by the acreage figures for the respective States, the result for the United States being a true weighted average for each subject.

There have been 18 meetings of the crop-reporting board during the past year, in most of which the personnel has been changed each month. Six special field agents, specialists in their respective lines of statistical and crop knowledge, and eight State statistical agents have served in the different board meetings. Most of these men are widely known throughout the United States, and the practice of having them take part in the preparation of the monthly crop reports and estimates has proved highly satisfactory, and has been a great factor in establishing the confidence of the public generally throughout the country in the fairness and correctness of the Bureau's estimates.

In 1905 comprehensive and stringent orders governing the preparation of the crop reports were promulgated. They have been found to secure expedition and safety in the computations, and have satisfactorily safeguarded the reports. Such orders have been revised to date and are strictly adhered to in every detail.

METHOD OF ISSUING REPORTS.

Reports in relation to cotton, after being prepared by the crop-reporting board and personally approved by the Secretary of Agriculture, are issued on the 2d or 3d of each month during the growing season, and reports relating to the principal farm crops and live stock are prepared and made public on the 9th or 10th day of each month. In order that the information contained in these reports may be made available simultaneously throughout the United States, they are handed, at an announced hour on report days, to all applicants and to the telegraph companies. These companies have reserved their lines at the designated time, and forward immediately the figures of most interest. A mimeograph or multigraph statement, also containing such estimates of condition or actual production, together with the corresponding estimates of former years for comparative purposes, is prepared and sent immediately to a mailing list of exchanges, newspaper publications, and individuals. The same afternoon printed cards containing the essential facts concerning the most important crops of the report are mailed to the 77,000 post-offices throughout the United States for public display, thus placing the most valuable information within the farmers' immediate reach.

LIBRARY OF THE

STATE STATISTICAL AGENTS.

Particular efforts have been made during the year to improve and perfect this important class of correspondents, and special care has been exercised in the selection and appointment of new agents where vacancies have occurred from death and resignations. Only men possessing proper qualifications and fitness have been selected, and then only after careful investigation by representatives of the Department. Many of the State agents have been visited and their offices inspected by officials of the Bureau during the year, and it is gratifying to note that their methods of securing data and compiling their reports have been brought to a scientific and uniform basis.

The appropriations of this Bureau were somewhat increased last year, and one of the principal reasons was to enable the State statistical agents to travel within and throughout their respective States for the purpose of making personal investigations of crop conditions, and of meeting their correspondents or aids, and enlisting the services of new ones. About $5,000 was allotted for this purpose during the year, and the State agents were directed to travel in the spring at the time inquiries are made as to the acreage of the principal crops, and also in the fall or near the time of harvest, when inquiries are made as to the yield and production. Excellent reports have been received from the different agents as to the great assistance and advantage of this travel, and it is felt that such benefits have been reflected in improved and more accurate reports from such agents.

SPECIAL FIELD AGENTS.

By means of a slight increase in the appropriation of this Bureau the corps of field and traveling agents was increased by the appointment of two additional men, and the territories of several of the agents have been redistributed and reassigned, so that the entire country is now better covered and represented by this class of reporters. The number of agents has been increased to 17; the principal cotton-producing States are now covered by 6 agents, while 8 others are assigned to the remaining territory of the United States, including the principal wheat and corn producing States, and 3 others are principally engaged in collecting statistics throughout the United States in regard to such crops as tobacco and rice.

INTERNATIONAL TRADE AND PRODUCTION STATISTICS.

Renewed efforts were made during the year to enlarge the statistical information of the Yearbook concerning international trade in agricultural products and concerning the agricultural production of all of the countries of the world for which information is obtainable. International trade tables are now compiled and published for corn,

wheat, wheat flour, and for wheat and wheat flour combined in terms of bushels of wheat; for cotton, unmanufactured tobacco, hops, rice, sugar, tea, coffee, oil cake and oil-cake meal; for rosin, spirits of turpentine, india rubber, wood pulp, wool, hides and skins, butter, cheese, live meat animals, and packing-house products. There are twenty-two commodities for which tables of the international trade of most of the countries of the world are prepared.

The statement of the agricultural production of all countries ascertainable has been enlarged by the inclusion of several products heretofore omitted, and the full list of these products now embraces fifteen products, viz, corn, wheat, oats, barley, rye, potatoes, cotton, tobacco, hops, flaxseed, rice, sugar, cocoa, silk, and wool.

The compilation of the number of live stock for all countries for which the facts are known or estimated has been improved and expresses the best information concerning the number of cattle, dairy cows, horses, mules, swine, asses, sheep, domesticated buffaloes, camels, goats, and reindeer.

MEAT SUPPLY AND SURPLUS.

An investigation in relation to the meat supply and surplus of the United States was made, to determine, among other things, the meat production of this country and the per capita consumption, the importance of the meat industry as indicated by the capital directly concerned, the disposal of the national surplus of meat among importing countries during a long period of years, the stock of meat animals at census dates beginning with 1840, and the declining per capita consumption of meat.

In this investigation attention was given to meat consumption by workingmen's families, as determined by the Bureau of Labor; to the prices of meat and the consumer's cost of the meat consumed annually. Much information was presented concerning the quantity of meat consumed in foreign countries. A specially full statement was prepared for Germany, made possible by the meat-inspection law of 1904.

This investigation made it possible to state the number of hides and skins produced in this country in 1900 and also the number of beef hides consumed in that year.

An investigation was also made of the restrictions against the importation of meat from the United States into principal European countries, which resulted in a summary of the prohibitions of principal European countries affecting pork, cattle, and beef, and of the restrictive measures which make the exportation of meat and meat products from the United States to these countries difficult, if not impossible, and of the technical procedures in exporting to those countries.

COMMENT ON CROP REPORTS.

During the year the Bureau and its reports have not been the subject of unfavorable comment and criticism, and it appears that the efforts which have been made to strengthen and improve the crop-reporting service have been productive of good results, which are appreciated by the country at large. Generally favorable and complimentary comments have been received from agricultural organizations in the South and throughout the country, who are appreciative of frankness, promptness, and accuracy in the preparation and publication of the reports.

THE LIBRARY.

The growth of the Library during the past year has been greater than that of previous years. It now contains 95,660 books and pamphlets relating to agriculture and kindred sciences and the subjects connected with the various activities of the Department. It is as far as is known the largest collection of agricultural literature not only in this country but in any country, and is indispensable in the work of the Department. The greater growth of the past year has been largely due to the increased number of publications received in exchange for the publications of the Department, especially from foreign countries. These exchanges form a very important part of the Library, without which the work of the Department would be seriously hampered.

During the past year 1,815 periodicals, exclusive of annual reports of societies and institutions, were received by the Library, and of this number nearly two-thirds were received by gift and exchange. In addition all the important current scientific works bearing upon the work of the Department are purchased, in so far as the funds of the Library permit. The catalogue of the Library has grown till it now contains about 185,000 cards, forming a valuable key to agricultural and scientific literature.

With the cooperation of the Library of Congress, the Library of the Department has continued the printed catalogue cards for accessions to the Library, and the printed catalogue cards for Department publications, which have proved useful to many libraries. Although the main use of the Library is in connection with the work of the Department, it is in addition the National library of agriculture, and the aim is to extend its usefulness as widely as possible, first by the completeness of its collection, second by the printing of catalogue and index cards and the publishing of special subject lists, and third by the loan of its books to scientific workers connected with the various State colleges and experiment stations. During the past year books have been sent to twenty-nine different States, from Maine on the east to California on the west. Each year the extent and importance

of the Library's collections is becoming better known, and the usefulness of the Library, not only to the Department but to agricultural scientists throughout the country, is shown to be steadily increasing.

OFFICE OF EXPERIMENT STATIONS.

RELATIONS WITH AGRICULTURAL EXPERIMENT STATIONS.

The work of the Office of Experiment Stations in its relations with the agricultural experiment stations throughout the United States has been largely extended during the past year on account of its new duties connected with the administration of the act of Congress of March 16, 1906 (Adams Act). Never before has there been such a widespread and thorough discussion of the nature, requirements, and limitations of the different classes of work which our stations have undertaken for the benefit of agriculture. As a result, the organization of the stations has been greatly strengthened and a large amount of fundamental research has been inaugurated, while at the same time broader efforts have been made to reach and aid the masses of the farmers, both by publications and by practical demonstrations of improved methods. The great need and opportunity for fundamental investigations in agriculture have been brought out very definitely, and the wisdom of Congress in providing liberally for the endowment of such research by enactment of legislation of a permanent character has been abundantly shown. It is also more apparent that the more directly practical experiments and demonstrations which have been so popular in the past appeal strongly to local public sentiment and can be readily supported by State appropriations. The legislatures which have met during the past year have shown much liberality toward the stations, and it is evident that the increase of National funds for these institutions will stimulate rather than retard State aid in their behalf.

The plans for the Adams fund work have been worked out with unusual care and deliberation, and, taken as a whole, they embody a large amount of investigation in the true sense, which will place agricultural science and research upon a higher plane. Considering the condition under which the first year's work had to be planned, the difficulty in securing men, the lack of uniform standards, and the diversity of views regarding what constitutes "original research" in agriculture, the programme must be regarded as very satisfactory. Not only has the amount of investigation greatly increased, but the outlining of the various undertakings in advance has also had the effect of systematizing the station work more thoroughly than ever before, and ultimately this should reflect favorably upon the activities of the station in other lines. If the system inaugurated for the Adams fund projects shall become more generally applied to the

station work as a whole, it will be an important result of the first year's operations under the new act.

Together with the strengthening of the organization of the stations, there has been a clearer differentiation between their legitimate work and that of the colleges, farmers' institutes, and other educational agencies. In a considerable number of instances special officers have been provided whose main duties are in connection with the investigations under the Adams Act, and a number of stations are looking toward the provision of a staff for the station work, practically distinct from the teaching staff of the college. This better provision for the station work will increase its efficiency, prevent serious interruptions, and make the station more strictly an institution for experimentation and research in agriculture.

The lack of men is one of the most serious drawbacks to development in this line, and it is now realized that the question of human equipment is the most vital question before the experiment stations to-day. During the past year the pressure has become intense, resulting in many changes of men from one locality to another and often preventing stations from inaugurating new lines of work. The well-trained man competent to originate and conduct thorough and satisfactory investigations is the all-controlling factor of success in agricultural research. Without such workers generous funds and elaborate equipment become ineffectual. The present shortage of men is due in part to the development incident to the increased funds, but in large measure to the new standards which are being established for station work. These standards impose additional requirements and qualifications, and thus practically eliminate from consideration many who might formerly have been thought eligible for station positions.

We must look to the agricultural colleges to train more men for this important work and to inspire them with the proper spirit and point of view. This will necessitate a further differentiation of courses of study to meet the needs of agricultural scientists as contrasted with those of practical farmers. Not only must the standard of undergraduate courses be raised, but special graduate courses of the most thorough character must be provided. Otherwise the development of the experiment stations will be delayed and the agricultural interests of the country will suffer.

The institution of so much research of a higher order in connection with the agricultural colleges and experiment stations is already proving a strong inducement to men of a higher type to engage in this work, and more young men of the right caliber are taking advanced courses in branches relating to agriculture. As soon as it becomes evident that our stations will pursue a consistent and permanent policy with regard to higher research in agriculture we may confidently expect a great improvement in the personnel of their staffs.

THE AGRICULTURAL COLLEGES AND SCHOOLS.

Each year now witnesses a great extension of the movement for the diffusion of agricultural education among the masses of our rural population. The national character of this movement has during the past year been conclusively attested by the passage by Congress of the Nelson amendment to the appropriation act for this Department for the fiscal year 1908, in which provision has been made both for extending the ordinary agricultural courses in our colleges and for the training of teachers of agriculture for the elementary schools. The celebration at Lansing, Mich., of the fiftieth anniversary of the beginning of agricultural education in this country marks an important step in the progress of the education of "the man who works with his hands." There have also been numerous local examples of the growth of this movement, notably the establishment of eleven agricultural high schools in Georgia, of single agricultural high schools in a number of States, and the enactment of permissive or mandatory legislation concerning agricultural high schools and the teaching of agriculture in the common schools in Texas, Michigan, and other States.

With every forward step in this movement greater demands for assistance are made upon this Department, and it becomes more clearly evident that in keeping with American custom in other lines some National agency is desirable to focus the experience gained in our several States and in other countries and, without exercising any control, but by diffusing information and stimulating local enterprise, to aid in systematizing and developing an efficient system of agricultural education throughout the length and breadth of our land. Such work in agricultural education as this Department, through its Office of Experiment Stations, has attempted to do has been along these lines. During the past year that Office, under authority granted by Congress, has responded to demands for services extending over the entire range of agricultural education from graduate instruction to the most elementary forms of extension work. Representatives of that Office have visited the agricultural colleges, prepared upon request courses in agriculture for agricultural high schools in Georgia and Maryland, addressed important meetings in the interests of agricultural education, and assisted at county institutes in preparing teachers of elementary agriculture.

Cooperation with the Association of American Agricultural Colleges and Experiment Stations in matters relating to agricultural education has been continued. As chairman of the standing committee on instruction in agriculture, the Director of that Office has aided in preparing exercises and courses of instruction for elementary and secondary public schools. He has also consented to act as dean of the Graduate School of Agriculture during its third session, in 1908, at

Cornell University, and begun to organize the faculty and work of that school.

As regards the subject-matter which is needed to form suitable courses of instruction in agriculture and to aid the teachers in elementary and secondary schools in adapting such courses to the requirements of different regions and different classes of students, the Office of Experiment Stations is in a position to render a service which it would be difficult for any other agency to perform. That Office regularly gathers and reviews practically all the literature on agricultural subjects issued by public and private institutions throughout the world. Out of the mass of material it now selects and abstracts for publication in the Experiment Station Record a few of the most important articles, but it could at comparatively little additional expense select and put in pedagogical form much more information that would be of very great service to teachers and students of agriculture in every State and Territory. If elementary and secondary instruction in agriculture is to be established in an effective manner and kept thoroughly alive and up to date our schools must regularly receive and utilize the new knowledge which the institutions for agricultural research and advancement are accumulating.

The information now issuing from so many sources and in so many languages and forms is at present almost wholly beyond the reach of the public school teacher. It must be worked over, selected, and published in usable form before the schools can effectually utilize it. No State agency is in position to perform such a service for the whole country, and it would therefore seem to be a proper function of the National Department of Agriculture and of that branch of this Department which is most closely in touch with both research and educational institutions working along agricultural lines. At relatively small additional expense the value and effectiveness of the aid which this Department is now extending to agricultural education could be multiplied several times.

FARMERS' INSTITUTES.

The reports received from the State directors of farmers' institutes show that there has been a large increase in attendance during the past year. The total attendance was more than 1,500,000, exceeding by several hundred thousand that of the previous year. Special subject institutes are rapidly growing in favor. Most of the States have held special dairy, fruit-growing, corn-judging, and cattle-judging institutes. These meetings were devoted to a discussion of some one of these topics, were continued from two days to a week, and were conducted by expert instructors who gave practical demonstrations in connection with their lectures. Seven States held special insti-

tutes for women, and contests in growing corn, wheat, flowers, fruits, and vegetables have been instituted in a number of States to interest the farmers' children in the institute movement.

The movement for supplementing the farmers' institutes by the holding of short courses of instruction in special subjects at the agricultural colleges and in different agricultural districts is growing rapidly and already attempts are being made to organize and develop these movable schools. To aid this movement by showing definitely the character of courses of instruction which might be given on this plan this Office has arranged with agricultural experts for the preparation of a number of such courses.

In cooperation with the standing committee on extension work of the Association of American Agricultural Colleges and Experiment Stations, this Office has made an extended study of the agencies outside of the farmers' institutes which are engaged in diffusing agricultural education among our rural people. The results of this investigation have been embodied in reports of the committee of the association and have been published as circulars of this Office. It is evident that a broad field of usefulness is opening before the agricultural colleges in extending their work of instruction among the masses of agricultural people who can not attend the courses given at these colleges. They are now beginning to organize and develop an adequate system of extension work in agriculture. To aid them in this work they are calling on this Office for services which are entirely beyond our power to perform with our present force. Since the National Government is so fully committed to the policy of giving the States assistance in diffusing scientific and practical information on agricultural subjects among our rural people, it would seem a wise thing to provide the comparatively small fund needed to make this Office an efficient clearing-house for this forward movement in agricultural education.

This Department and the agricultural colleges and experiment stations are doing a great work through their publications and courses of instruction, but as yet the masses of our farmers are only indirectly and superficially affected by the work of these institutions. Strenuous efforts and a broadly organized movement will be required to bring home to the masses of our farmers the results of exploration and research on their behalf. It is time that careful attention should be given to devising efficient ways and means for completing the great work of agricultural advancement to which both the Union and the States have committed themselves.

Foreign countries for many years have appreciated the importance of orally instructing rural people in agriculture. In addition to agricultural teaching in their universities, colleges, normal schools, academies, and secondary and common schools, numerous special classes of

adults are organized in the country districts for instruction by itinerant methods. Professors of agriculture under Government direction are sent out to give instruction in the normal and rural schools, and to organize farmers' societies for the promotion of agriculture. Numerous agricultural high schools have been established, particularly in Denmark and Sweden, and are attended by large numbers of rural people of mature years. Demonstration fields showing the effects of various manures, methods of culture, and varieties of seeds upon crop production are found everywhere. More than 3,000 of these demonstration fields and farms are in operation in France alone.

Movable schools of agriculture form an important part of the educational system in all of these countries. They embrace schools of general agriculture, schools of forestry, horticulture, market gardening, apiculture, aviculture, dairy schools, poultry rearing, farriery, domestic science, and on other similar agricultural subjects. Expert advisers are employed by the State to visit individual farmers and give advice with regard to the methods of operation best adapted to their conditions. Universities and colleges are extending their activities to outlying communities, to farming people who are unable to leave their farms to attend classes at the collegiate centers. The practical results of the foreign system of agricultural research and education are shown in the increased production of these countries as compared with the United States, where the masses of the farmers have not been reached by organized educational agencies.

INSULAR STATIONS.

The experiment stations in Alaska, Hawaii, and Porto Rico have made pronounced progress during the year, and their efforts in the development and diversification of agriculture are beginning to be appreciated in their several communities.

The Alaska stations are devoting their efforts to live stock, horticultural crops, and cereal growing. In continuation of the policy of developing a station herd, there are now over 40 head of Galloway cattle divided between the Kenai Station and the newly established animal breeding station on Kodiak Island. The principal experiments at the central station at Sitka are along horticultural lines and plant breeding. As a result of the plant-breeding experiments, hybrids of strawberries, raspberries, and other small fruits have been produced and are under observation. These are the results of crossing some of the native hardy species with improved varieties. Cereal investigations and the production of forage are being given especial attention at both the Rampart and Copper Center stations. Winter wheat and winter rye and spring-sown wheat, rye, barley, and oats matured their crops at Rampart during the past season, as they have done every year since the establishment of the station in 1900. Some of the varieties of cereals ripened at Copper Center, several hundred miles

farther south, but nearer the mountains. At both stations the production of grain hay has been shown possible. Work was begun this year at the station in the Tanana Valley near Fairbanks, and a considerable area was cleared and prepared for cultivation. The special agent in charge anticipates important results from the establishment of this station, as it is nearly in the center of a large area that is apparently capable of considerable agricultural development.

The Hawaii Station has continued its investigations along the lines of diversified agriculture, devoting especial attention to investigations on tobacco, rubber, rice, and honey and fruit shipments. That cigar tobacco of good type can be successfully grown in Hawaii has been proved. The rice investigations have already shown the possibility of greatly increasing the yield of that crop, and at the same time the expense of production may be reduced by the adoption of more modern methods of cultivating and handling the crop. The planting, cultivation, and tapping of rubber trees and the coagulation of the latex are being investigated, and promising results have already been obtained. The experiments in fruit shipment have been continued, and it has been shown possible to land Hawaiian pineapples and avocados in Chicago in excellent condition. These investigations are of great economic importance to Hawaii, as they show the possibility of supplying the markets of the western portion of the United States with tropical fruits. Studies have been made that lead to a better understanding of Hawaiian honeys, which will possibly result in an enlarged market for that important product.

The Porto Rico Station is giving its attention to problems of soil management, crop rotation, methods of cultivation and improvement, horticultural problems in connection with citrus and other fruits, pineapples, etc. Following the successful efforts of the station in shipping pineapples to New York and other markets, large quantities of the more desirable varieties are now being exported. The station is carrying on cooperative work with planters along a number of lines, and the results of these efforts are beginning to be seen in the adoption of improved methods of crop production. The coffee experiments have been especially valuable, and if the economic conditions relating to the marketing of the crop should be changed, the suggestions given regarding planting, fertilizing, cultivation, pruning, and shading will be widely adopted. The collections of economic plants are being extended, and the horticulturist reports the successful introduction of a considerable number of varieties of European and American grapes. The entomologist has devoted much of his time during the past year to combating the insects occurring on citrus and other trees, and reports the discovery of a very active parasite on the eggs of the tobacco horn worm. It is believed that this parasite can be successfully utilized.

The stations are all developing quite rapidly, and for their proper support I recommend for them appropriations equal to the amounts given each of the State stations under the Hatch and Adams acts.

NUTRITION INVESTIGATIONS.

The nutrition investigations, carried on under the auspices of the Office of Experiment Stations, were undertaken primarily to learn the nutritive and economic value of agricultural products of animal and vegetable origin used as food for man. In carrying on the work during the past year it has been the policy, as in the past, to cooperate with agricultural experiment stations, agricultural colleges, universities, and other institutions in different States and Territories, and to establish centers of investigation wherever an institution or region offered special facilities. Thus, cereals and cereal products have been studied at the Maine and Minnesota agricultural experiment stations, the nutritive value of fruit and nuts at the California Experiment Station, and the nutritive value of cheese at Middletown, Conn., and the Minnesota Experiment Station. In this way the Department funds have been materially supplemented by the contributions of the cooperating institutions and the results obtained have been large in proportion to the outlay. New experiments have been undertaken whenever the completion of any line of work has rendered this possible, and the enterprise as a whole has been systematized and grouped as a series of projects in accordance with the general plan for the work of the Department of Agriculture.

The Washington office has been responsible for the plans for the work as a whole, for the editing of the results, and the distribution of information, as well as for some special investigations.

The experiments at the California Agricultural Experiment Station have demonstrated the comparatively thorough digestion of fruits and nuts of different sorts and the nutritive value of these important crops and their value as foods rather than food accessories.

At Middletown, Conn., the results of respiration-calorimeter experiments have been prepared for publication on the subjects of muscular and mental work as related to energy income and outgo and the demands of the body for food. From the elaborate experiments reported it does not appear that mental work exercises a positive influence on metabolic activity—that is, on the amount of oxygen consumed and carbon dioxid and energy given off from the body—nor does it modify the body demands for nutrients and energy. Muscular work, on the other hand, is absolutely dependent on the energy supplied by the food or material stored in the body from previous food supply. The total energy output, which may be readily determined with the respiration calorimeter, is a definite measure of the total work performed by the body, and hence of the amount of energy

which the food must supply for the performance of a given kind and amount of work. In other words, it is possible to determine with the respiration calorimeter energy requirements as expressed in dietary standards.

Man's efficiency as a machine for the performance of work has been studied in connection with the respiration-calorimeter experiments and found to be 21 per cent in round numbers, or much higher than that of even the most perfect engine.

In accordance with the action taken by Congress at its last session, the respiration calorimeter and accessory apparatus have been brought from Middletown, Conn., to Washington and stored.

The experiments on the digestibility and nutritive value of different kinds of cheese, carried on at the Minnesota Agricultural Experiment Station, supplement earlier work of this character at Middletown, Conn., confirm the results obtained, and materially extend the conclusions reached. As shown by the large number of digestion experiments with healthy men, cheese, both the ordinary American Cheddar and other sorts studied, is on an average very thoroughly digested without physiological disturbance and compares favorably with other staple foods as a source of nutrients and energy. In other words, cheese is to be regarded as a food for use in quantity when desirable or convenient rather than as a condiment for occasional use.

At the University of Illinois the experiments on the effects of different methods of cooking on the nutritive value and digestibility of meat of different kinds and cuts have been continued. The conclusion reached is that meats of all kinds are to be ranked among the very digestible foods. No marked difference was observed in either the ease or thoroughness of digestion of different kinds or cuts.

Experiments on domestic canning and preserving of vegetables have been continued at Wellesley College, Massachusetts, and as a result of this inquiry and earlier work satisfactory methods have been devised and await publication.

The studies at the University of Chicago of the changes brought about in cooking fruits and the effects of different methods on the yield and quality of the cooked product have furnished valuable data applicable in domestic jelly and jam making.

At the Maine Agricultural Experiment Station investigations regarding the digestibility and nutritive value of different sorts of corn meal prepared for the table in a variety of ways have been continued, and the work as a whole has demonstrated the high nutritive value of this important cereal crop and shown the reasonableness of its use in quantity as an integral part of the diet.

The studies of the effects of different methods of grinding on culinary quality, which have been made at Teachers' College, Columbia University, New York, have made it plain that by suitable

methods of manipulation in cooking it is possible to obtain uniform results with both old water-ground and new-process meal.

As a result of the extended work on corn a Farmers' Bulletin has been prepared, summarizing available data on the use of this cereal as food.

As regards the digestion, assimilation, and nutritive value of flour products other than bread, the investigations which have been carried on at the Minnesota Agricultural Experiment Station, in continuation of earlier work on cereal foods, show that such goods closely resemble bread in their digestibility and that the various methods of handling flour in cooking and the combining with it of other foods, as shortening, do not materially affect the proportion which is digested.

At Columbia University, New York, studies on the ash content of foods have been continued, and a bulletin has been prepared setting forth the results obtained with calcium, magnesium, and phosphorus.

Cooperating with Drexel Institute, Philadelphia, dietary studies have been made in a home for aged women and an orphan asylum. It is proposed to incorporate the results with those of similar work carried on in Baltimore institutions as a contribution to the question of dietetics in relation to institution management. The results also supply valuable information regarding food requirements in early youth and old age as compared with the period of full vigor.

Studies of the pedagogics of nutrition have been continued, especially in cooperation with Teachers' College, Columbia University, New York, and a large amount of data has been collected and systematized regarding the higher courses in domestic science which are given in American agricultural colleges, universities, normal schools, and kindred institutions. The total number at present on record which give such courses is 150, of which one-third are institutions receiving Government aid. The courses vary decidedly in scope and extent, but the importance which the subject of home economics is assuming in modern education is very apparent from the data available. The nutritive value of food is one of the important subjects included in such courses, and in these institutions, as well as in medical colleges, Department nutrition publications are very commonly used as text-books, owing to the fact that other satisfactory reference works on the subject have not hitherto been available. These publications are also largely used in the numerous secondary and elementary schools where courses on foods and cooking are given.

The results of the nutrition investigations are made public by means of technical bulletins and popular summaries, and in addition a great deal of miscellaneous information is supplied to teachers, students, and other persons by means of correspondence, the increasing demand

for publications and other data being an indication of the favorable way in which the work is regarded by the people at large.

The problems concerned with the rational and economical utilizations of agricultural products as human food are so intimately and vitally related to those connected with the production of the food staffs on the farm that the nutrition investigations may well be a part of the work of this Department. The experimental methods which have been elaborated and the lines of work which have been followed in the nutrition investigations are well fitted to supply the information which is needed in order to utilize in a satisfactory way the available food supply in the proper and economical feeding of families and groups. In view of the demonstrated usefulness of this work and the large demand for information along these lines, especially for use in connection with our public and private schools, where the scope of instruction relating directly to home life of our people is being steadily enlarged, I earnestly recommend that provision be made for the continuance of these investigations. A place has been provided in the new Department building for the respiration calorimeter, and it will be possible there to continue the fundamental researches which are required to put our knowledge of the utilization of food in the body on a thoroughly scientific basis.

IRRIGATION AND DRAINAGE INVESTIGATIONS.

Recently the chief of irrigation and drainage investigations has accepted an invitation of the Australian government to take the supervision of the work in irrigation which that government is about to undertake for the benefit of agriculture in that country, and has withdrawn from the service of this Department. This has opened the way for a reorganization of our irrigation and drainage investigations, which seemed advisable in view of the present extent of this enterprise and a quite distinct differentiation of the irrigation work from that in drainage, both as regards the character of the projects and the regions in which they are carried on.

IRRIGATION INVESTIGATIONS.

The work of this Department in irrigation divides itself into three geographical divisions, each with its own peculiar problems: The older irrigated sections, where the irrigated area has been extended to the limit of the water supply and where economy in water is the most pressing necessity; the section just brought under ditch, where water is plentiful for the present and where the prevention of waste of labor and money by the settler in bringing the land under cultivation is a condition of success; and the sections where farming has been

carried on without irrigation but where droughts occur with sufficient frequency to make success doubtful, or where raising prices or soil exhaustion makes more intensive farming necessary.

The work in the older sections consists of experiments to determine the losses of water under ordinary practice and how these losses may be prevented. Water is lost by seepage from ditches, by evaporation from water surfaces and from the wet soil, by percolation beyond the reach of plants, and by waste which may seem necessary to properly wet the soil. We are making experiments to find cheap and effective ditch linings to prevent seepage losses, which in many instances are more than 50 per cent of the water entering the ditches. We have made experiments to determine the losses by evaporation and the effectiveness of different methods of applying water and cultivating the soil after irrigation in checking these losses, the results showing that half the water lost in this way can be saved. We have made observations to determine how far the water applied by different methods to different types of soil penetrates into the soil for the purpose of adapting methods of applying water to soil conditions in such a way that proper moisture conditions may be maintained without loss by percolation beyond the reach of plant roots or by surface run-off.

During the past five years construction of irrigation works has outrun settlement. During that time the Government has expended $40,000,000 in irrigation construction, and private parties at least an equal amount. A canvass recently made indicated that as a result of this activity there would be at least 5,000,000 acres of unreclaimed land provided with a water supply ready for settlement in 1908. The cost of preparing this land for irrigation and providing the equipment for successful farming will be fully as great as the cost of building the canals to bring water to it, so that when the canals are built the work of reclamation is but half done. The safety of this whole investment in irrigation works and in the preparation of land for use, and, what is much more important, the safety of thousands of future homes, depend upon the use of proper methods both in the preparation of the land and in the subsequent use of water. The cost of the irrigation works, whether they are built by the Government or by private parties, must be repaid by the settlers, and their success or failure means success or failure for the projects. These settlers must come largely from sections where irrigation is not practiced, and will be unfamiliar with the use of water. Mistakes in the preparation of the land and in the adoption of methods of applying water are costly not only in the time and labor lost, but also in decreasing crop returns, and, in addition, they come at a critical time, when payments for land, water, implements, stock, and food are all pressing. It is our endeavor to aid the settlers at this crucial time

by telling them how to do the work with the least expenditure of time and money, and in such a way as to get the best results. This is done through bulletins, the giving of practical directions through personal advice by the more experienced of our field men, and through demonstration farms established under cooperative agreements with local parties, with State experiment stations, and with the Reclamation Service of the Department of the Interior.

In the semiarid region the four irrigation extension farms established last year have been maintained. Each is situated where no large supply of water is available and where most of the land must be farmed without irrigation. These stations are to determine and demonstrate the possibilities and cost of irrigation with the small water supplies which can be made available in these regions in the hope that the irrigation of a small area in connection with the use of drought-resistant crops and intensive cultivation on a much larger area may enable settlers to successfully maintain homes on the high plains, which otherwise must be devoted to grazing only.

The rush of settlement in this region in the past few years is in many respects similar to previous waves which have swept over it, and many have feared a repetition of the former disasters which wrecked so many homes and lives. It is to guard against this that we are making every effort to provide the settler with a means of pulling himself through the years of drought, while looking to the wet years for his profit.

It is our belief that irrigation may profitably be extended into other sections where it has not been considered necessary. We are this year carrying on experiments to determine this in the Willamette Valley in Oregon and in the Sacramento Valley in California, while we have maintained an experiment as far east as Iowa. Previous experiments have shown that irrigation is profitable as a crop insurance, even in the extreme East, and a knowledge of its possibilities and methods will lead to its extension in the future, until it will be practiced to some extent throughout the United States.

In many places where irrigation is now practiced water is secured by pumping, and the extension of irrigation into many sections will depend upon the ability to secure water in this way cheaply. The use of power in irrigation and drainage is made a part of our work, and we have made many tests of pumps, engines, and windmills, in order to be able to answer the inquiries received from those wishing to pump water for irrigation. These tests show efficiencies of the pumping machinery varying from 5 to 80 per cent, thus demonstrating the great need which our farmers have of accurate information on which to base their purchases of machinery suited to their purposes.

DRAINAGE INVESTIGATIONS.

This line of work has developed and expanded more rapidly during the last year than ever before. The demands for information, assistance, and advice in relation to the drainage of agricultural lands in all sections of the country have been so numerous that it has been beyond the physical possibilities of the available office and field force to comply with all the requests, and it has hence been necessary to postpone compliance with many meritorious applications for assistance.

The drainage work has been carried on along the following well-established lines:

(1) The examination, study, and comparison of past and current drainage practice as developed under differing conditions in various sections of this country and abroad, with special reference to determining the success or failure of the various methods attempted in solving the problems of agricultural drainage, and the efficiency or inadequacy of the various systems for use in those localities where drainage is an important factor in agricultural development. The information thus collected is arranged, systematized, and issued in bulletin form as rapidly as practicable, with the object of furnishing to the public generally, and especially to agricultural engineers and those charged with the responsibility of the successful carrying out of drainage enterprises, a comprehensive, reliable, and up-to-date body of knowledge covering the scientific bases upon which all successful drainage work must rest, and an epitome of the best practice as developed under recent conditions. It is the intention thus ultimately to have a complete compendium of the knowledge necessary for the planning and execution of drainage work under all the great variety of diverse conditions which obtain in the different portions of this country—knowledge which now does not exist in any available printed form and the lack of which is responsible for a large portion of the requests for information which now come to this Office from engineers and technically educated men.

(2) Assisting farmers, communities, and States in the initiation and direction of drainage improvements. It has been the unfortunate experience of most localities requiring drainage that a large portion of the first attempts to secure needed improvements have resulted in failure. Such attempts resulting in total or partial failure not only entail the involved financial loss and delay, but have tended greatly to discourage and render more difficult the prosecution of other meritorious enterprises. Nevertheless, out of such a history of numerous failures and difficulties in accomplishing adequate drainage many communities in those States where drainage has been satisfactorily accomplished for many years have evolved

from a state of unhealthfulness and poverty to a condition of unrivaled prosperity. It is with the hope of preventing expensive mistakes and avoiding exasperating delays, with their attendant discouragements, that this Office assists in the inauguration of drainage projects. This assistance is given most fully in those States and localities where drainage is a new feature, so that the results of previous similar local work are not available as a guide and example. The most common errors in the preparation of plans for drainage arise from a lack of the technical knowledge requisite to secure good engineering design, and from a want of appreciation on the part of those undertaking the work of the size and extent of work necessary to secure the desired effects. In these matters this Department is in position, by the experience and standing of its staff, to give advice which carries such weight as to settle local differences of opinion and promote the cooperation of all the parties at interest.

(3) Examinations and experiments relating to such technical problems pertaining to land drainage as to which there is at present a lack of existing knowledge. These investigations include a study of the drainage coefficient of agricultural lands of different types, the relation of flood run-off to different climates and kinds of topography, systems for draining muck lands which border on peat formation, the movement and behavior of water in irrigated land, the laws of erosion of ditches and of the sedimentation of ditches, tests of the best methods of making, handling, and using cement drain tile, and similar questions. As an illustration of this kind of experimental work, the Office is now conducting experiments as to the efficiency of the use of drain tile in the far North, where the ground freezes to a depth of 6 feet or more in the winter; in the sticky and impervious gumbo soils of the southern Mississippi delta region; and in the exceedingly fine volcanic ash soils of the irrigated Rocky Mountain region.

The operations of the drainage investigations have included work during the past year in about two-thirds of the States of the Union. The survey of the Kankakee Valley project in Indiana was completed and a report embodying the results of three years' investigation was prepared and transmitted to the local authorities. Nearly half a million acres in this valley were once a marshy plain. During the last twenty years numerous small projects for the improvement of the drainage of separate portions of the upper end of the valley and areas along its outer margins, by means of straightening, cleaning, and deepening parts of the channel of the river and its tributaries, have been successfully completed. In this way large areas have been rendered available for profitable agriculture. At the time this Office took up the work local jealousies and differences of opinion had

reached such a state that it seemed impossible for the various interests to reach an agreement which would lead to the relief and improvement of the large and important areas embraced in the main lower part of the valley.

As a result of the careful surveys and studies by the engineers of this Office a comprehensive plan was prepared in this Office for increasing the carrying capacity of the lower portion of the river channel by shortening its length from 72 miles to 42 miles. This is accomplished by cutting off 84 bends of the present stream by cuts varying from 150 to 5,500 feet in length. The excavation of this channel will require the removal of nearly 10,000,000 cubic yards of earth and will cost approximately $1,000,000. This improvement involves six counties in Indiana and one in Illinois. Probably 500,000 acres of land will be directly benefited. The value of these improvements can scarcely be estimated, although similar land in Indiana has risen in value from $5 to $100 per acre after drainage.

During the winter of 1906–7 a preliminary survey was made of a part of the Everglades of Florida, an area of swamp land covering some 5,000 square miles. A line of levels was run from Fort Myers, on the Gulf coast, across the glades south of Lake Okeechobee to the Atlantic coast, connecting on the way with the surface of Lake Okeechobee. This survey was made in the face of great physical difficulties, it being necessary for the men engaged to carry all their supplies for a distance approximating nearly 50 miles through soft muck, with the aid of canoes for only part of the way. This was the first time that a survey had ever been carried across the region, although there had been numerous previous attempts. The results so far attained encourage the hope that the further investigations which will be made will prove the practicability of reclaiming profitably for agricultural use a large area of this land, which is now too wet to be successfully cultivated and is hence practically worthless.

Surveys of the lowland subject to injury by overflow lying along the Red River of the North in North Dakota were concluded in Pembina County, thus completing the project previously begun and embracing also Cass, Traill, Grand Forks, and Walsh counties. The total area surveyed was about 3,000 square miles. Plans and estimates were prepared for drains for this entire area. The work was carried out under a cooperative agreement among the counties interested, the State engineer's office of North Dakota, and this Office. The report has been printed and submitted to the local authorities.

The field work was completed and plans prepared and submitted to the people for improving the Neosho River in southeastern Kansas. The watershed drained by this stream embraced 5,090 square miles and the plans provide for the protection of 161,000 acres of overflowed land, at an average cost of $9 per acre. It is generally conceded that the loss and damage from the overflow in 1904 were more

than the estimated cost of protecting these lands. The report discusses fully the engineering problems involved, and the accompanying maps give the elevation of the overflowed lands and the profile and cross section of the stream and the details of the proposed improvement.

Much attention has been given to the possibilities of drainage in the Delta region of the lower Mississippi Valley. A very active interest has recently developed in drainage in this region. In Arkansas, Louisiana, Mississippi, and Missouri there is a constantly growing agitation of the matter. The completeness of the levee system is now rendering safe the expenditure of large sums for the improvement of the low flat lands formerly subject to overflow by the Mississippi floods. This Office has made preliminary examinations of large portions of this region and has so far as means were available assisted in the organization and plans for actual drainage construction for definite limited areas.

The problem of the reclamation of the swamp tide lands along the Atlantic coast has been frequently urged upon this Office, and has received special attention during the last year. Special examinations have been made in various localities, advice has been given, plans have been prepared, and publications have been issued devoted to this phase of drainage. Experiments to determine the best methods for the removal of excess seepage water and accumulated alkali from the irrigated regions in the West have been continued.

Gratifying reports have come to the Department from localities where the drainage plans, prepared in previous years, have been put into execution, showing the great benefits which have accrued to farmers who have carried out the advice given by this Office. During the last fiscal year plans were prepared for the drainage of about 2,000,000 acres.

OFFICE OF PUBLIC ROADS.

It is the province of the Office of Public Roads to investigate the various conditions affecting the public roads and to ascertain and make known the remedies for the evils in existing systems and methods of road construction and administration. During the past year the work of the Office was divided into twenty-two projects, dealing with practically every subject of interest in connection with wagon roads. This represents a greater number of projects than have been undertaken in any single previous year.

ROAD MILEAGE, REVENUES, AND EXPENDITURES.

The close of the year marked the completion of the first census ever made to determine the road mileage, revenues, and expenditures in this country. This investigation was begun early in 1905. Information covering the calendar year 1904 was obtained from carefully

selected correspondents in every county in the United States, from State highway departments, State geologists, city and county officials, employees of the Office of Public Roads on field duty, commercial and agricultural associations, and newspapers—in fact, every possible source of information was used. In some of the States reports were made by townships. While these reports are in some cases incomplete, the greatest care has been taken in their verification, and the results as a whole are reasonably accurate. The bulletin recently issued on this subject shows the enormous total of nearly 2,152,000 miles of public road; that 7.14 per cent of this mileage has been improved, and that the total expenditure for 1904 was approximately $80,000,000. Considering the fact that our improved roads have been in process of construction for a number of years, it becomes evident that the results which we are obtaining are totally inadequate to the amount of money expended, and that the mileage is so great that we must of necessity classify our roads according to their importance, bearing in mind the fact that by far the largest proportion of our earth roads must be maintained as such for many years to come.

METHODS OF ROAD CONSTRUCTION AND MAINTENANCE.

The construction of object-lesson roads in cooperation with local authorities was continued during the year along the same lines as in previous years, excepting that greater attention was given to the building of earth, sand-clay, and gravel roads. In every case the local authorities furnished common labor, materials, teams, and fuel. The engineers of the Office of Public Roads were instructed to ascertain in their preliminary work as accurately as possible the character of construction best suited to the locality, and under no circumstances to recommend the building of a road which, though excellent in itself, might represent a form of construction ill suited to the locality or too costly to be continued. Sixteen roads were completed during the year, representing a total of 200,711 square yards, which is far greater than the amount completed in any preceding year. The work of construction was supplemented when practicable by informal lectures, explaining the methods used in building the object-lesson roads.

The endeavor has been made to reduce the cost of construction to the lowest point consistent with efficiency, recognizing the fact that the cost of building improved roads is the chief obstacle in the way of their general adoption. The cost of macadam in a road built at Williamsburg, Va., was only 36.3 cents per square yard, or at the rate of $2,556.22 per mile, exclusive of engineering assistance and machinery furnished by the Office.

Work on the object-lesson roads was carried on during the year in Alabama, Arkansas, the District of Columbia, Kansas, Kentucky,

Louisiana, Maryland, Montana, Nebraska, North Carolina, Oregon, Tennessee, Virginia, and Washington.

A bulletin on the construction of macadam roads, based upon the best practice in the States which have made the greatest progress in macadam road building, was issued during the year. Earlier studies of sand-clay and burnt-clay construction showed these to be valuable methods in those sections of country where hard materials are lacking.

The mixing of sand and clay has long been recognized as an effective method of road construction. The burning of clay for railroad ballast was begun some years ago, but its adaptability to road building has only been made known by this Office in recent years.

Experiments in the use of burnt clay as a road material at various points in Mississippi give most favorable indications of success, and it seems quite probable that a long step forward has been taken in solving the road problem in the Mississippi Delta.

The maintenance of earth roads has received special consideration, and an expert in the construction and use of the split-log drag has been employed to aid in the general introduction of this simple and effective means for bettering earth roads.

Many failures in road building are due not so much to a general disregard of standard methods of construction as to serious mistakes in some particular feature of the work. For instance, the cost of quarrying the stone may be excessive through ignorance of the best practice; the road may prove unsatisfactory because of a poor location or on account of the use of inferior material. In all such cases expert examination and advice will go far toward enabling the local road officials to remove the difficulty. During the past year about forty such assignments were made from the Office of Public Roads. In one county in Alabama a strong movement was on foot to issue bonds for a large amount for the purpose of building macadam roads. An engineer detailed from this Office upon request ascertained that the conditions were satisfactory for building sand-clay roads and very poor for building macadam roads, the material for the latter being inaccessible except at great cost. He advised the building of sand-clay roads. His advice was followed, and to-day that county has 118 miles of road built at a cost of $22,000 which meet the requirements of traffic practically as well as macadam roads would do.

LECTURES.

The trend of public opinion with reference to our public roads is indicated by the requests which have been received during the past year for the detail of men to lecture on road improvement. In former years the demand for lectures on road improvement came largely from road organizations, but during the past year requests have been received from agricultural, industrial, scientific, and commercial

organizations which are taking up the subject. These requests have been complied with as fully as possible, and the most careful effort has been made in all cases to confine the lectures to practical topics, and to give information and advice based upon actual experience and careful study of the subject. In all, about 150 lectures were given during the year.

INSTRUCTION IN HIGHWAY ENGINEERING.

The plan of appointing graduates of engineering schools to the position of civil engineer student in the Office of Public Roads has been continued during the past year with marked success. The necessity for competent highway engineers to direct the work of road building along proper lines has become increasingly apparent in recent years. The remarkable success of the French road system is largely due to the fact that the Government maintains a school of roads and bridges, from the graduates of which is recruited a thoroughly efficient corps of highway engineers. The course of training given in the Office of Public Roads of this Department covers a period of only one year, but instruction even to this extent is beneficial to the student, the public service, and the city, county, or State which eventually employs the young man receiving such instruction. Six students were appointed during the past fiscal year, making a total of fifteen since the inauguration of this project.

A plan for introducing more thorough and practical courses in highway engineering in the various schools and colleges was put in operation during the past year, whereby engineers of the Office of Public Roads are detailed for a series of lectures on highway engineering at some time during the regular school year.

INVESTIGATION OF THE PROPERTIES OF ROAD MATERIALS.

The total number of road-material samples received for testing during the year was 405, as compared with 384 for the preceding year. The greater number of samples were received from State geologists and State highway commissions, a gratifying fact, since it insures the best disposition of the data obtained in the Office of Public Roads. The State geologists of Maryland, Massachusetts, Montana, and New Jersey, and the highway commissions of Connecticut, Massachusetts, Minnesota, Ohio, Pennsylvania, Rhode Island, and Virginia cooperated in this manner.

During the year progress was made in the design of special equipment for conducting road-material tests. The most important addition to such equipment was a new impact machine for testing the toughness of road-building rock. In July, 1906, specifications developed in the Office of Public Roads for determining the toughness

of rock for road building were submitted to the American Society for Testing Materials and adopted by that society.

As a result of the petrographic examination of rocks used in road making, a classification of such rocks has been made and facts of importance gained bearing on the relation of the physical properties of rocks to their mineral composition and structure.

SPECIAL INVESTIGATIONS.

I desire to call special attention to the investigation relative to the corrosion of iron. This investigation, begun in connection with the subject of metal culverts and fence wire, has produced results of far-reaching importance. It has demonstrated that the generally accepted theory regarding the oxidation of iron is incorrect, and that by treating the surface of iron with a strong oxidizing agent the rusting can be inhibited so long as the oxidizing agent is present.

Experiments conducted for several years relative to the decomposition of rock powders have also led to valuable results. A fact of great importance in road construction established by this investigation is that a better bonded surface for roads can be secured by mixing rocks such as limestone with the more siliceous crystalline rocks. This work has led to a more extended investigation relating to the extraction of potash from feldspathic rocks. Reference has been made to this work in previous reports, and it has been described in several bulletins. It seems probable that these studies will develop a method commercially practicable for extracting potash from feldspathic rocks. If this is done our dependence upon foreign sources of supply for potash will be decreased, at least to a certain extent.

COOPERATION WITH DEPARTMENTS AND BUREAUS.

During the past year more than thirty rural-delivery roads were inspected, in cooperation with the Post-Office Department, at a cost of only about $950 to this Department. Much improvement has resulted from these inspections.

Between August 17 and October 14, 1906, an engineer from the Office of Public Roads made an investigation of the roads and trails in the Yellowstone Forest Reserve upon request of the Forest Service. A report containing recommendations and estimates was prepared and submitted to the Forester.

The Department cooperated with the Navy Department in the construction of a shell road at the New Orleans naval station; with the War Department in experiments with dust preventives, and with the Geological Survey in designating on topographic maps the character of the roads shown.

INVESTIGATION OF ROAD MATERIALS IN THE SEVERAL STATES.

Previous to the past fiscal year no personal investigation of road materials in the several States had ever been made, owing to the magnitude of the work and lack of appropriation. Last year, however, a cooperative arrangement was entered into whereby the State highway commissioner of Minnesota was made a special agent of the Office and assigned to the work of investigating the road materials in that State. This work will be completed during the present calendar year. It is intended that such an investigation shall be conducted in each of the States as rapidly as facilities will permit. This investigation is designed to ascertain the location, character, quality, quantity, and accessibility of all road materials in the respective States, cost of transportation by rail, by water, and by wagon, suggestions for possible methods of quarrying, probable markets for material, feasibility of using convict labor in the preparation of material, and other essential points.

MODEL COUNTY SYSTEMS.

The roads of a county should be built according to a predetermined and unified system, based upon a most careful investigation of materials, amount of traffic, revenue available, methods of construction adapted to local needs, organization and administration, and all factors entering directly or indirectly into the road work. A plan was inaugurated during the past year whereby the most competent engineers of the Office of Public Roads were assigned, upon request of county authorities, to make such an investigation and to prepare for the future use of the county road authorities an exhaustive and detailed report with plans, estimates, and recommendations indicating the location of all materials, advising which should be used, indicating the roads that should be improved and the method and cost of improvement suggested, needed changes in organization and in methods of administration, and in short affording a guide for future county road work.

The first assignment of this character was made at Santa Barbara, Cal., followed by work of a similar character in Los Angeles County. The success of this work has been recognized, and Los Angeles County is now proceeding under recommendations made by the engineer of this Department.

INVESTIGATION OF DUST PREVENTIVES AND ROAD PRESERVATIVES.

In recent years perhaps the most important and certainly the most difficult problem which has engaged the attention of highway engineers is the prevention of dust. Until the general introduction of motor vehicles dust was considered as neither more nor less than a

nuisance. The problem has now, however, assumed a more serious aspect. The existence of our macadam roads depends upon the retention of the rock dust formed by the wearing of the surface. Under ordinary traffic conditions this dust remains on the road and consolidates to form a fresh wearing surface. But a heavy rubber-tired automobile moving at a high rate of speed produces a partial vacuum behind each wheel which sucks up the dust from the road surface and throws it into the air to be carried off by the wind. This action soon strips the macadam road of all fine material, the result being that it soon disintegrates.

France, both by reason of her large mileage of macadam roads and the general use of automobiles, has given this subject the earliest and most thorough consideration. Investigations and experiments have also been conducted in England, and to some extent in this country. During the past year a thorough investigation was made of the systems in use both in France and England. Experiments with tar and oil were conducted during the past summer in Kentucky and Massachusetts with a number of materials and preparations designed to preserve macadam road surfaces.

This is a subject which should engage the earnest attention of the National Government at once. No matter how important we may deem the building of good roads, we can not but consider it even more important to preserve those which have already been constructed. Investigations of dust preventives and road preservatives will be conducted by the Office of Public Roads during this and the next fiscal year as far as its facilities will permit.

THE DEPARTMENT'S WORKING FORCE.

The report of the Appointment Clerk shows that there were on the rolls of the Department at the close of the fiscal year 9,107 employees. Of the entire force, 1,972 were employed in the District of Columbia and 7,135 outside of the District.

The following figures are sufficient to show the growth of the Department during the past forty years: In 1867 the total number of persons employed in the Department was 99; in 1877 the total number was 77; in 1887 there were 328 employees; by 1897 the number had increased to 2,444; and on July 1, 1907, the total number of persons employed had reached 9,107.

OFFICE OF THE SOLICITOR.

Questions affecting the operations of the Department under the statutes committed to it for execution were frequently referred to the Solicitor during the year for written or oral opinions, and several

important confidential investigations of a quasi-legal character wer conducted under the direction of the Secretary. The correspondenc connected with the enforcement of the twenty-eight-hour law is ver voluminous. There were 677 cases under this law transmitted to th Department of Justice during the year. Eight cases under the Lace Act (act of May 25, 1900) regulating interstate commerce in gam were reported to the Department of Justice. The Department se cured a conviction in the only case reported under the act of June 2 1906, prohibiting trespass upon the bird reserves set apart for its us by orders of the President. Recovery of property of the Weathe Bureau withheld by former employees was effected through th Solicitor in the three cases reported by the Bureau. In a number o cases pending in the Court of Claims at the close of the year th Solicitor assisted the special attorneys for the Government in procu ing the evidence and preparing the papers. During the year the D partment secured a conviction under the cattle quarantine law (a of May 29, 1884), and reported a number of cases to the Departmer of Justice, which are now pending. Under the cattle quarantine a of March 3, 1905, three convictions were secured in cases reported b the Department. Several others are pending. In addition to the cases there were 215 complaints against railroads for violation of th regulations of the Department governing the placarding of cars i interstate shipment of cattle from quarantined area investigated b the Solicitor and taken up by him with the respective railroads wit a view to securing a rigid compliance with the regulations in th future. The meat inspection amendment of June 30, 1906, went int force in October of that year. One case had been reported to the D partment of Justice before the close of the fiscal year. In Decembe the Department secured the conviction of a man who attempted t bribe a live-stock inspector, and he was fined $300 and sentenced t ten days in jail. The meat-inspection amendment of June 30, 190 imposes upon the Secretary the duty of prescribing regulations for it enforcement. In this work the Solicitor rendered assistance, as wel also as in the preparation of the decisions announced by the Depart ment in its interpretation of the food and drugs act. Three patent for Department employees were procured during the year, and other applied for. The Solicitor is one of the three members of the Boar of Food and Drug Inspection, in which capacity much of his time i spent. He is likewise a member of the committee on personnel o the Department for the investigation of all serious delinquencies oc curring among the employees thereof.

NEW BUILDING FOR THE DEPARTMENT.

The work on the new building for the Department has progressed tisfactorily during the year, and it is hoped to occupy the new arters within the next month or two. As pointed out in my last port, in considering the question of a building, the imperative ed for suitable laboratories to carry on the important investiga- ns of the various bureaus and fireproof space for the library was cognized as paramount. The greater part of the indoor work of e Department is conducted in laboratories, hence the absolute neces- y for structures that would be well lighted, well ventilated, fire- oof, and otherwise well adapted for the purpose. To accomplish ese several objects and at the same time to secure opportunities for ntinued enlargement, the building has been arranged so that exten- ns could be made in segments as the work required.

When the act authorizing the building was passed we could not rese the rapid growth, by Congressional action, of the Department. n February 3, 1903, when the work was authorized, there were in ashington 1,100 persons employed in the Department of Agricul- re. At the present time there are over 2,100—almost double the mber on the date when the appropriation was made.

While the original appropriation was so expended as to secure the eatest possible amount of floor space, this floor space is now totally adequate to care for the increase of almost 100 per cent in the num- r of employees. Full arrangements have been worked out for the cupancy of the present segments and the relinquishment of the veral buildings for which rent is now being paid. The work will completed within the appropriation made by Congress.

Details of the work of the Department are contained in the accom- nying reports of the various Bureaus, Divisions, and Offices, the iblication of which in connection with this report is respectfully commended.

Respectfully submitted.

JAMES WILSON,
Secretary of Agriculture.

WASHINGTON, D. C.,
November 23, 1907.

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PROGRESS

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LETTER OF TRANSMITTAL.

U. S. DEPARTMENT OF AGRICULTURE,
BUREAU OF PLANT INDUSTRY,
OFFICE OF THE CHIEF OF BUREAU,
Washington, D. C., May 1, 1908.

SIR: I transmit herewith the manuscript of the annual report on the Progress of the Beet-Sugar Industry in the United States in 1907. It consists of the report of the special agent, Mr. Charles F. Saylor, and a brief account of the studies and investigations pursued by members of the staff of this Bureau.

I recommend that this manuscript be published as Report No. 86 of this Department.

Respectfully,

B. T. GALLOWAY,
Chief of Bureau.

Hon. JAMES WILSON,
Secretary.

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PROGRESS OF THE BEET-SUGAR INDUSTRY IN THE UNITED STATES IN 1907.

REPORT OF THE SPECIAL AGENT,

CHARLES F. SAYLOR.

INTRODUCTION.

Owing largely to climatic conditions, results in the beet-sugar industry throughout the different States were not as uniform and not as satisfactory on an average in 1907 as in 1906. Sugar beets are not more influenced by varying conditions than any other crops, but being a comparatively new crop, results are more closely scrutinized by the public. As a matter of fact this crop has proven more reliable and more capable of certain forecast than almost any other.

The outlook for extending the beet-sugar industry, considering all the circumstances, continues bright. There are many projects on foot for establishing new factories, but the effect of the financial stringency, characterizing the advent of the year of 1908, is nowhere more apparent than in this new field. On this account it does not seem probable that many factories will be installed in 1908.

COMBINATION OF INTERESTS.

The sugar business of the United States has consisted largely in the refining of imported raw sugar. The jobbers, wholesalers, and retailers have distributed the refined product to consumers. These refining interests have turned their attention to the beet sugar with a view to producing the raw and refined sugar from home-grown products. They, with the home manufacturers of sugar, are getting together—combining—to manufacture, refine, and dispose of the sugar required in this country to be made from beets and cane. The close of 1907 indicates that these investing and business interests are more united than ever in the manufacture, refining, and distribution of the home sugar production.

LAND SPECULATION AS A FACTOR IN DEVELOPING THE SUGAR INDUSTRY.

The arid and semiarid lands of the West for several years appear to have offered the chief field for developing the beet-sugar industry in the United States. For this reason it is often assumed that the

industry is becoming localized in the arid West. This is more apparent than real. The tillable lands of the valleys in the intermountain and coast States, as a rule, are well adapted to the sugar industry. For some time it has sought this locality, where it has been more readily and successfully established. But the causes leading to this are largely local, and, to some extent, temporary. The rapid progress of the beet-sugar industry in the West is largely due to the following causes: (1) Owing to natural conditions the available uses to which land could be put have been very limited, grazing being in fact the chief use; (2) their value ($1 to $5 per acre) has been based on their limited earning power as grazing land; (3) any new enterprise naturally looks to the speculative as well as the permanent phases of the investment.

Speculation has, indeed, had much to do with installing the beet-sugar industry, and it probably will have for some time to come. These cheap lands, when watered by irrigation and planted to fruit or utilized in any form of intensive agriculture, are capable of wonderful increase in values. Under natural conditions they may not have any considerable earning power, but with irrigation their value is enormously increased. It is well known that an available supply of water and a sugar factory offer all the opportunity and assurance needed to induce capital to build an irrigation ditch. Most factories built in this dry country of the West were established on account of the opportunities to develop certain tracts of land. Promoters reap the harvest which results from this large increase in land values. At the same time the factory is permanently equipped to do its work in a profitable manner.

Often a company develops a sugar-beet district, builds a large factory, opens up the irrigation ditches necessary, and invests the capital required to bring to the highest utility a large tract of land. Around some of these plants, large tracts of land are still the property of the plant. As beet growing develops, all other features of intensive farming develop proportionately. Lands formerly worth a few dollars per acre become permanent assets of the plant or the owners, worth $200 to $300 per acre. Such opportunities for land speculation do not exist in the older settled States such as Wisconsin, Ohio, and New York. It is largely the speculative possibilities that have taken the sugar industry to the West.

The greatest need of an arid new country is some industry like sugar manufacturing, which offers an incentive for the investment of capital. The sugar industry leads and encourages all others in this respect. It not only complements all kinds of agricultural production, but it combines all industrial effort. It absolutely necessitates the irrigation ditch. It is a guarantee of success to many other branches of industry. Its inauguration leads to the building of rail-

roads and trolley lines, the establishment of creameries and dairies, the development of stock breeding and feeding and poultry raising, the manufacture of alcohol, and other industries related in one way or another to the sugar industry.

The substantial lines of agricultural industry in the East are established, but the arid and semiarid lands brought under irrigation are virgin soil open to any use. It is easy to plan a new building, but to remodel an old one is difficult. This illustrates the real difference between installing sugar factories in the arid West and in well-developed agricultural districts of the East. For some time to come the sugar industry may grow faster in the West, but it costs less to produce beets in districts receiving moisture by rainfall than by irrigation. Rentals and land values are steadier in the East. The sugar industry with its associate features of development always influences these values. Eventually the sugar industry in the arid country will reach its speculative maximum. The cost of producing beets and the cost of fuel and transportation are lower in the East, and markets are more accessible. In time these advantages will so exert themselves that the East and the West will be producing sugar more in proportion to the lands available for the purpose.

MANUFACTURE OF DENATURED ALCOHOL.

I desire at this time to call attention to the production of alcohol as one of the industries related to the beet-sugar industry. Recent legislation promoting the production of denatured alcohol to be used in the arts and sciences will redound to the benefit of the sugar industry. It will take time in this country to develop this new phase of alcohol production. Sources, means, and methods must be worked out. The waste molasses furnishes an excellent raw product for use in its manufacture. Experiments indicate that the starches and sugars contained in the pulp may possibly make it useful for the same purpose.

In Germany, France, and England, where alcohol production has developed to a considerable extent, the raw material is largely from the field crops, principally potatoes and beets.

IMPROVEMENTS IN FACTORY CONSTRUCTION AND EQUIPMENT.

The character of new factory construction and the class of machinery installed are matters worthy of special comment. My observation during the past year in this respect especially enforces the importance of the improvement. Originally factories were built cheaply and less substantially than they should have been. Some of them were of poor construction, with the inner framework of wood and hence not fireproof. Some of the first factories utilized buildings formerly constructed for other purposes, remodeling them, but never making them entirely satisfactory.

With hardly an exception the factories established during the last two years have buildings of the finest masonry, steel-framed, with cement floors, and practically fireproof.

In some of the older factories second-grade machinery was used, often second-hand or imported machinery of old types and patterns, requiring large expense to remodel for effective work. Those of recent construction are made according to the most modern patterns and of best materials. In these new plants most of the machinery was made in this country.

HOW THE INDUSTRY GROWS.

In the pioneer work of establishing the beet-sugar industry, those who undertook the location and construction of factories could have no guides in the selection of location except the study of conditions and results of experimental work in growing beets. As a natural result, some mistakes were made. This method of deciding on a location has now been almost entirely superseded by a more natural and logical process of growth. Now a new factory is nearly always located in a district in which beets have been grown on a considerable scale for an older factory. It often happens that a factory in securing acreage for a sufficient supply of beets has to reach out into one or more districts that are somewhat remote, thus developing beet growing over a large territory. When, later on, the acreage devoted to beet growing near the factory increases, the management may find it impracticable longer to handle the beets grown in some outlying district, and it furnishes both the demand and the opportunity for the establishment of a new factory in an area where sugar-beet production is a demonstrated success. The company which originally developed beet growing in this district may embrace the opportunity thus opened by building an additional factory. If it does not, some other company already in the field may undertake to establish a plant, or an entirely new company may be organized for this purpose. This process of growth involves but a fraction of the hazards and difficulties involved in the pioneer method, and the results are almost invariably satisfactory.

DISTINGUISHING FEATURES OF THE BEET-SUGAR INDUSTRY.

In the northern half of the country the beet-sugar industry is now practically distributed from the Atlantic to the Pacific. It has developed many substantial features. To an extent it has intrenched itself in public confidence as a permanent industry worthy of attention and consideration. It is no longer an experiment. Its establishment seems permanent, its development healthful, and its future assured. These conditions have been brought about through many influences. Considering the industry's future in this country and the factors favor-

able to its development compared with those opposed, I am disposed to be optimistic.

Throughout the world's competition, in the production and marketing of sugar, we find arrayed the two rivals—the cane-sugar industry and the beet-sugar industry. The contest is between two phases of agriculture which are diametrically opposed in nearly every respect—geographical location, moral, social, and civic ideals, and community of interests. It is a contest between the domination of capital unhampered by organized labor or social barriers on the one hand, and on the other a branch of industry in which human rights and privileges must receive high consideration. In the Tropics, cheap labor and bountiful production oppose the more complicated enterprises and expensive conditions of the Temperate Zone, where industry is dominated by a spirit and policy which places the general welfare above every other consideration. To build the sugar industry in this country required intelligence, energy, sacrifices, and the indomitable spirit of progress. No one influence is entitled to all the credit. The Department of Agriculture, with its great scientific bureaus, has given this industry standing and power. This Department has been ably assisted by the State experiment stations, which have in a large measure worked out the culture problems through experiments and investigations, developing facts and disseminating knowledge. The public press, both general and agricultural, have kept abreast with this work and greatly aided in disseminating information and educating the public. All these influences have tended to stimulate organization and active work on the part of farmers, business men, and capitalists.

EDUCATING AND DEVELOPING INFLUENCE OF THE BEET-SUGAR INDUSTRY.

In a sugar-factory district the inexperienced growers are not left to their own resources in producing this new crop. They are under contract with a sugar factory to produce beets, and this contract covers the methods that shall be employed. In seeing that these methods are followed the responsibilities of the factory management are as great as those of the farmer. Unless the factory can receive beets that are at least up to the minimum requirements in sugar content and purity, it can hardly hope to succeed. One of the chief responsibilities of such a plant rests upon the agriculturist. The contracts with the farmer make it incumbent on them to produce beets in accordance with certain stipulations under the direction of a representative of the factory. The men chosen as such representatives are experienced agriculturists, in some degree scientists, thoroughly acquainted with the best methods of agriculture, the action of the soil, and the management of men. They have a corps of assist-

ants constantly moving about among the beet growers, seeing that they do the necessary work to produce beets that will meet requirements of the factory. This agricultural superintendent and his representatives are in constant touch with the beet growers, advising them with reference to all the details of preparing the land, cultivating the plants, and harvesting the crop. While their instruction is specific with reference to beets, they are constantly advising as to the production of all crops. If a piece of ground shows poor results from lack of drainage, its improvement in this respect is advised, and so with reference to fertility, or any other feature. These advisers, representing the sugar factory, fully understand that a plant costing hundreds of thousands is no temporary affair. They appreciate that the relations of the plant with the agricultural community will last longer than one year. While they are striving to bring the best results from a crop of beets planted each year, they are also endeavoring to best prepare the land and the farming community to serve the interests which they represent for a long period of time. They know that a tract of land should not grow beets more than a year or two, after which it must go into other crops in a cycle of rotation, eventually to produce beets again. They look forward to the planting of additional lands each year, and for this reason they must advise in regard to drainage, rotation, fertilization, the selection of the best seed, and everything that has to do with the success of all the crops of the farming community.

There is no one fact more constantly in the mind of the management of the sugar factory than that it must take the initiative in improving the agricultural practice of the community and assume responsibility for the results of its experts. This work requires patience and energy, and involves expense. The management appreciates that the longer the factory has been established the more its difficulties will diminish and the less its advice will be needed.

One of the things that has impressed me most in studying the general tendencies of the beet-sugar industry is the wonderful influence it is having on all that class of farmers, tenants, and laborers who may properly come under the term of beet growers. It is generally improving the productiveness of the soil, and the one feature of greatest importance is the tendency to methodical production of all crops.

In a district undertaking the cultivation of this crop, its needs must necessarily affect the whole field of agriculture. To adapt a field to the production of beets requires time, patience, expense, and intelligence. The ultimate results depend on several things: (1) The natural adaptability of the soil; (2) its manipulation for a series of years; (3) the rotation adopted; (4) the farmer who applies his labor and intelligence at the proper time and in the right way to achieve results.

Under the system of agriculture in this country, it is customary to assume that farming is a simple process. Anyone reared on a farm, under the ordinary acceptation of the term, is called a farmer. Thousands of such people eke out an existence. They subsist, defray their expenses, and close their careers, leaving the world about as they found it, without having improved it or their own conditions. This class has lived in vain. They have not helped their calling or added anything to the world with all its opportunities.

In agriculture in this country we have been busy pioneering, opening new settlements, and have never been really competitors. We have been doing things in a haphazard way. The world calls for our productions, and they are sold. We have exerted our energies and paid our debts. At the close of the year we know that we have lived, we are still alive, and have enough to live on until the next crop. Profit and loss are things not under consideration. Declining years, waning powers, have no terrors. We have simply drifted with the tide. But now we have reached a new era. The productive lands of this country are nearly all settled. Every acre must necessarily become a competitor of every other in this broad land. Rentals, values, and profits must be measured by the sales book and cost of production. We must be more methodical and must look more to the future.

A sugar factory not only intensifies the farming but makes the land support a larger population. In sugar-beet districts, the number of inhabitants deriving their living from farming is increased many fold. The factory becomes the nucleus of settlement. The growth of the community leads to the establishment of graded schools and brings the improvements enjoyed by older communities. Railroads are established, trolley lines are built, churches are organized, and free mail delivery is installed. This brings the daily press and the telegraph and telephone. It also brings together and organizes the people of the district for social and business cooperation. In such a community we find the people organized for serious consideration of everything that has to do with public roads, schools, churches, and social, business, and intellectual progress.

COSTS AND PROFITS OF SUGAR-BEET GROWING.

As elsewhere stated in this report, the usual estimate of cost for growing beets under rain conditions is $30 per acre; under irrigation, $40. The usual price paid for the hand work, when done under contract, is $20 per acre for the season. The actual cost of production naturally varies a good deal with conditions. Under exceptionally favorable conditions, beets may be grown and harvested for somewhat less than $30 per acre; but if the season is bad, and labor scarce and dear, the cost may considerably exceed $40 per acre. For the

years 1901–1906, the lowest annual yield of sugar beets per acre for the whole country was 8½ tons in 1903; the highest annual average was 11¼ tons in 1906; and the mean average for the six years was 9½ tons per acre. These average yields are for the total acreage harvested, and do not include any abandoned acreage. The price paid for sugar beets delivered at the factory varies somewhat, but the usual price is $5 per ton, and this may safely be accepted as an average price. The average yield of 9½ tons per acre, at an average price of $5 per ton, gives $47.50 as the average gross return per acre of sugar beets for the entire country for the six years. If we assume that $35 is the average cost of production per acre, $12.50 will represent the net return per acre of sugar beets. This net return represents rent of land, interest on capital, and profits.

That it is possible to secure net returns vastly greater than the average just given has been repeatedly demonstrated by results over large areas. It is not uncommon for individual growers to secure gross returns of $75 to more than $100 per acre.

In former reports I have given detailed statements of operations in beet growing in cases where accounts were kept, and the actual costs and returns could be shown. The following are similar reports which I have secured during the past year.

The following report by E. C. Amann, cashier of the Crawford County Bank, and secretary of the Beet Growers' Association, Prairie du Chien, Wis., shows what live men can do, when properly organized, in investigating conditions as regards the sugar industry, at the same time securing substantial returns:

In regard to the sugar beets which were grown here in 1906, I am inclosing you a report made by the local Beet Growers' Association. We rented 50 acres of land and hired a manager and hired all the work. As you will see 15 of us put in $60 each and when the books were closed we returned to the stockholders the amount of the investment and gave each stockholder a check for $86.26. The report which I inclose you herewith gives the items in detail.

Our soil is sandy and the beets seem to grow very rapidly and show a high percentage of sugar. There is no question in my mind but what, if we were assured that a sugar factory would be located here, we could secure contracts for 3,000 to 4,000 acres. We have a large territory to draw from and one particular advantage of our soil is that after a heavy rain the farmer can work his field the next day owing to the sand absorbing the water. This is a very strong point, especially when beets are weeded and thinned. By giving the beets the proper attention at the proper time, there is no necessity of letting the weeds get ahead of the beets.

We rented a 50-acre field which we planted to beets. We figured that we had about 48 acres of beets, 2 acres being deducted to allow for land covered by buildings, and for land not used. Fifteen of the business men joined this association and each agreed to make payments up to $100 to cover the expense. After payments had been made up to $60, the sugar company made us a loan of $10 an acre and the remittances we received from the company gave us sufficient working capital so that it was not necessary to have the stockholders make any more payments. As you will see from this statement, we returned the $60 to each stockholder, and have a net profit of $1,293.98, besides hav-

; tools worth $55.40. We, of course, think growing sugar beets is like "getting money m home."

We were told that our 50 acres was the largest field of beets in the State; and as we ed all the work done, besides paying a superintendent, we consider the earnings as owing what can be done in raising sugar beets. The percentage of sugar this year s not as high as the average for 1905. We expect to grow 100 acres next year.

Very truly,

BEET GROWERS' ASSOCIATION,
E. C. AMANN, *Secretary*.

RECEIPTS.

id in by stockholders, $60 each	$900.00
y 21, 1906, lumber sold (farm shed removed)	10.00
tober 6, 1906, loan from beet-sugar company	[a] 500.00
cember 26, 1906, remitted by company for beets	1,573.52
cember 26, 1906, applied by company to payment for seed	112.50
cember 26, 1906, applied by company to payment of freight	182.22
bruary 6, 1907, balance remitted by company for beets	1,176.02
Total receipts	4,454.26

EXPENDITURES.

mt		400.00
ols:		
Lifting forks	$1.50	
Knives	7.90	
Beet lifters	7.00	
Two plows, one beet lifter	21.50	
Weeders	17.50	
		55.40
owing and seeding		141.60
ltivating beets		130.70
inning beets		315.16
pping and pulling		409.85
uling		272.15
perintendent		240.70
ed		112.50
eight		182.22
yment made by stockholders returned		900.00
Total expenditures		3,160.28
Cash on hand—net profits		1,293.98

RECAPITULATION.

tal tonnage from 48 acres	tons	728.5
erage yield per acre	tons	15.1
tal deduction for tare	tons	39.0
erage content of sugar	per cent	13.2
tal gross returns for beets		$3,544.26
oss returns per acre		73.85
xpense per acre		46.90
et profit per acre		26.95
tal net profit		1,293.93
ofit for each stockholder		86.26
st of tools remaining on hand		55.40

[a] This item was afterwards deducted from the value of the beets delivered to the ctory, and may therefore be considered as an advance payment for beets.

The Detroit (Mich.) Farmer of March 9, 1907, publishes a carefully itemized statement of the cost and profits of growing sugar beets:

Another successful season for beet growers in the Saginaw Valley is past and in view of two good seasons in succession growers are making contracts for increased acreage next spring. Below are a few figures secured by Midland County growers last season.

Mr. J. E. Sayres harvested 78½ tons of beets from 5 acres (15.7 tons per acre) and sold them at a flat rate of $5 per ton delivered at the weigh station in Midland. He kept a careful itemized account of the expenses of growing the crop, a summary of which follows:

Costs and results of growing 5 acres of beets in Michigan.

Gross returns, 78½ tons of beets, at $5		$392.44
Plowing and preparation of land	$10.50	
Seed	7.50	
Drilling	3.50	
Cleaning with horse weeder	1.50	
Thinning and hand weeding	29.60	
Cultivation to July 27	19.75	
Pulling and topping	40.00	
Hauling to car and cellar	49.40	
Hauling from cellar to car	15.00	
Total cost		176.75
Net returns		215.69
Net per acre		43.14

Mr. Sayres also charges his account with $6 per acre for rent of land; this leaves him $37.14, which is practically all clear profits. The extra $15 for hauling from cellar to car resulted from car shortage at hauling time. Mr. Sayres has been extremely careful in keeping his accounts and is well satisfied with the results.

The Montpelier (Vt.) Argus, of August 7, 1907, contains the following:

In Boulder County, near Denver, in 1906, 71,800 tons of beets were grown, averaging 15 to 17 tons to the acre. The total cost of growing an acre of sugar beets has been itemized as follows by an authority on that subject, Mr. F. D. Coburn, secretary of Kansas State board of agriculture: Plowing, $1; seed, 20 pounds, $2; planting, 50 cents; bunching and thinning, $6; hoeing and cultivating, $10; harvesting and topping, $8.50; interest on land, irrigation, hauling, and general charges, $9.50; total, $37.50. The net profit on 17 tons to the acre at $5 a ton is, therefore, $47.50. One grower reported a net profit of $85.50 an acre in 1906.

USE AND VALUE OF BY-PRODUCTS

The by-products which result from the growing of sugar beets and the manufacture of sugar therefrom are the tops and leaves, the pulp of the beets after the sugar has been extracted, the refuse molasses, and the unmarketable beets. All these are valuable food for farm animals.

TOPS AND LEAVES.

The tops and leaves are that part of the beet crop left in the fields when the beets are prepared for delivery to the factory. After the beet is taken out of the ground, a portion of the top carrying the

leaves is cut off. Often this refuse is allowed to cure on the ground and is plowed under. It has considerable value as a fertilizer. If the plans of the farmer contemplate the building up of the soil in some other manner, the tops and leaves may be used as stock food. In many places the stock is turned in on harvested beet fields and allowed to eat the refuse as it lies on the ground. On other farms, this refuse is carefully gathered, brought to the barn and stored, and fed to the stock as needed. The best use to be made of this refuse depends upon circumstances, but whatever the use, its value must not be lost sight of.

SUGAR-BEET PULP.

To the farmer the pulp is one of the most important by-products of the sugar factory. After the beets are delivered to the factory, cleaned, and sliced, the sugar is extracted from them. The residue is called the pulp.

The beets are cut up into long slices or strips about the size of a lead pencil. These slices, called cossettes, are not mashed or squeezed, their sugar content being simply dissolved out by the action of hot water. After this is accomplished, they are immediately removed to the dump, or silo. To the factory this is refuse to be disposed of. Often it occupies needed room and its removal entails expense. In many such cases it is given away. This is often the case with a new factory. In other older factory districts, or in those where stock interests are largely developed, it is sold for a nominal sum, the price depending upon the demand. When pulp is sold, it usually brings from 10 cents to $1 a ton, depending on the circumstances.

Many tests have been conducted in this country by State experiment stations and extensive feeders to ascertain the actual value of pulp as compared with other stock foods. This value depends largely upon the purposes of feeding. Estimates of the value vary from $1.50 to $4 per ton. Beet pulp has much hygienic value, as, being a succulent feed, it promotes digestion. It also takes the place of other rough feed. Experiments indicate that, when combined with other foods, it increases their food value.

The use of pulp for stock feeding has an important bearing on the future of the sugar industry. When a factory with ordinary capacity consumes 50,000 tons of beets, it turns out about 25,000 tons of pulp. It makes a vast difference whether this shall be thrown away—disposed of at an actual expense—or sold at so much per ton and removed by the buyer. Its importance will be more strongly emphasized when our farmers come to appreciate that it has an actual value of twice or three times the highest cost figure mentioned.

In most of the older countries of Europe the pulp is all consumed. Every pound is utilized with profit to both the consumer and seller.

In Europe pulp is considered of such importance that it is specially prepared by drying for general distribution and sale. The wet pulp coming from the sugar factory generally carries about .90 per cent of water. It is put through a process of drying in a special kiln, after which it is baled or sacked and shipped to all parts of the country. Everyone owning an animal uses it. We must in the end do the same in this country to utilize its value. Several of the earlier factories built in this country have since installed drying plants to prepare this stock feed, and some of the later ones have included such plants.

On account of its bulk and the cost of transporting its useless water content, the market for wet pulp must necessarily be confined to the immediate vicinity of the sugar factory. Dry pulp can be shipped like other dry feeds to all parts of the country.

While a number of factories in this country are now preparing dried pulp for general distribution, most factories supply only wet pulp.

A farmer can practice economy by delivering a load of beets to the factory and taking home a load of pulp. It is a product that is very easily stored and kept. Often farmers build special silos to receive it, though this is not necessary, as the pulp is not harmed by freezing. It may simply be piled in the open. If it is put in a conical pile, it will shed rain. In this condition it will keep two or three years. Freezing, rainfall, and hot weather seem to have very little deteriorating effect. But it deserves better care.

MOLASSES.

When the sugar has been dissolved from the pulp the solution contains much of the original impurities of the beet. In the process of sugar making it becomes necessary to eliminate the impurities, and some of the sugar goes with them. After all the sugar has been secured that can be extracted by ordinary methods we still have a refuse known as molasses. This refuse is an astringent mass made up of some sugar and the impurities and wastes. Analysis shows that it is from 45 to 49 per cent sugar, the rest being water, different salts originally in the beets, and other matter introduced in the extraction of the sugar.

During the campaign a sugar factory will turn out a considerable quantity of this molasses. Much study has been given to the use of this waste product. It contains much that is of commercial value, and by proper manipulation can be used as raw material for manufacture into valuable products, such as stock food, shoe blacking, glue, alcohol, fertilizers, etc. In Europe it is commonly used in the manufacture of alcohol, and a beginning along the same line has been made in this country, notably in Michigan.

We are just beginning to utilize the by-products of the sugar industry in profitable manufacturing. Until we shall have attained the

full development of this feature we must utilize in a more or less crude way the available materials.

Much of the molasses of Europe is mixed with the pulp before it goes through the drying process, and the result is a very desirable food for stock. On account of its salts, the molasses is too much of a laxative and also too astringent in taste to be fed alone; but, mixed with a large amount of pulp and then dried in kilns, it is very palatable and nutritious.

SUGAR BEETS FOR STOCK FOOD.

Under the contract the factory makes with a beet grower he must grow beets which come up to a certain standard of quality—usually 12 per cent of sugar with a purity of 80. When the beets are delivered he may be "docked" on account of beets not reaching this standard. This does not often occur, but sometimes it does. In such cases the crop of beets is not a loss. They are still valuable for stock food on his farm. Docking at a sugar factory is very rare and affects but a very small percentage of the total crop grown. When his beets are refused the farmer may store and feed them to his stock. For this purpose they are worth almost as much as for delivery to the sugar factory. It has been demonstrated time and time again by experiment stations of this country that there is no more valuable root crop for stock than sugar beets. It is not uncommon for stock feeders to stop farmers on the road with beets for a factory and pay the same price for use in feeding. Thus the farmer gets the same price with a short delivery.

In growing sugar beets for stock food it is not necessary to give the same care as in producing for the sugar factory. A farmer can usually grow twice the tonnage of stock beets as he can for factory use. Many farmers growing beets for the factories also grow a large tonnage of beets for their stock. This tendency is growing all the time. Farmers of this country are too much inclined to feed corn exclusively on account of its fattening qualities. Animals fattened on a ration which includes roots and other succulent feed yield carcasses that bring the highest price on the block.

Beets are easily stored in cellars, caves, or pits. They can be sliced and mixed with ground feeds and fed in the raw state or cooked with different grains in the preparation of slops and mashes for all classes of animals.

STOCK FEEDING.

One of the main advantages incident to the beet-sugar industry is its benefit to stock breeding and feeding. I have insisted on this throughout my reports and feel warranted in emphasizing it. Probably there is no other fact more certain than that this industry has had more influence in extending and developing the stock interests

of the country than any other. Especially is this true in the intermountain States, where the sugar industry has been developed faster.

A few years ago the stock interests of the West were confined mainly to grazing. While this western country still possesses much of its grazing facilities, having a great amount of land adapted to nothing else, the sugar industry with its pulp, molasses, beets, and beet tops, has revolutionized the stock business. The sugar factory has brought transportation facilities, the drainage ditch, labor, and other utilities. Through crop rotation it has stimulated the growing of other crops, such as alfalfa, barley, spelt, rye, etc., which can be fed with the pulp. Thus the stock grower has a balanced ration, not only for breeding and rearing stock, but for fattening and for producing milk, butter, and cheese. Under such conditions the "range horse" is becoming a thing of the past. The range remains simply one of the factors in a system for producing standard horses for all classes of work and use.

A trip through the sugar districts of Colorado, a State now possessing 16 sugar factories, all of comparatively recent date, will demonstrate this great transformation. The same can be observed in Utah, Idaho, Montana, and California. Around most of these factories thousands of sheep and cattle are fed annually, and dairying is rapidly developing. The old ranches are installing new buildings and equipment for breeding, raising, and finishing animals for the market. Much of the stock now produced on the range is brought into these places, fed on the ration produced at home, and shipped to eastern markets, in competition with the corn-fed stock of Iowa, Illinois, Indiana, and Ohio.

THE LABOR PROBLEM AND THE BEET-SUGAR INDUSTRY.

The labor problem is one of the most difficult in general agriculture in this country. There is not a place in the United States devoted to agriculture, whether the crops be general or special, where this question is not one of vital importance. The development of factories and mines and the demands of commerce have tended, on account of higher wages and greater opportunities, to attract the labor away from the farm, and there has been a steady movement of population toward the cities. Throughout my report I have insisted that the beet-sugar industry tends to counteract and correct this tendency. A sugar factory is an organized institution requiring large capital, but it must be located in a district where its raw material is produced. Unlike many other factory enterprises, it is not dependent upon the conditions and advantages of a large city. Many sugar factories are built in small villages. At the same time, a plant of this kind, involving a capitalization of $350,000 to $1,500,000, must necessarily deal with labor problems, the same as a steel mill, or some

other industrial enterprise found in the large cities of the country. It is the first requisite of every sugar factory to see that sufficient laborers are secured for growing the beets, and for doing the work of the factory. Agents qualified for this work are immediately put into the field to secure these laborers. They keep informed concerning the immigration of laborers from foreign countries, and carefully investigate the labor supplies of large cities. One of the first things that will be noticed upon the establishment of a sugar factory in an agricultural district is the influx of labor from varying sources. It is necessary to reiterate these facts, in order to counteract an idea which seems prevalent in the public mind, viz, that the labor problem offers such an obstacle as to thwart the success of a sugar factory in a farming district where labor is scarce. When a new factory is under consideration for a district, the farmer says: "I can not possibly secure enough help to do the work I now have on the farm. What can I do if I sign a contract to grow an intensive crop like sugar beets, thereby very much increasing the amount of labor required on my farm?" The reply to such a statement is that the sugar factory will solve this difficulty. To the ordinary farmer this answer seems paradoxical, but it is perfectly logical. In watching the development of conditions around every sugar factory now in operation in the United States, I have yet to find a case where the advent of the sugar factory has not attracted labor, not only for growing beets, but for all kinds of farm work.

In some districts where sugar factories have been established, factory agents go to the cities and hire large numbers of school children between the ages of 9 and 21. These are usually employed during the school vacation. They are quick and well adapted to certain lines of work in growing beets, such as weeding, bunching, and thinning during the growing season, and topping and piling when the crop is harvested. In addition to the school boys and girls, every city affords a large supply of laborers perfectly adapted, whether by former experience or sufficient intelligence, to do the work of growing the beets. Many of these laborers—Russians, Germans, French, Austrians, Hungarians, Portuguese, etc.—are immigrants from Europe with more or less experience in beet culture. Most foreigners have had some training in the rural districts in the countries from which they come. These countries, as a rule, have smaller farms, and must necessarily cultivate them more intensively. If they have not grown beets, they may be familiar with gardening and truck farming, and therefore adapted to the work of growing beets.

Every season sees more and more laborers trained for work in the beet fields. As the industry grows the supply increases, and keeps more nearly even with requirements than in other lines of agriculture.

It requires from 120 to 150 days to produce the beets and deliver them to the sugar factory. The sugar factory will see to it that its beet fields and factory are supplied with laborers. Throughout the beet-growing season laborers will devote many days to other lines of work for the farmers in the district. They are always available for this purpose after the harvest, so that a farmer growing sugar beets is not only put in a position to get help for beet farming, but also has a more available supply of labor for all other work on his farm.

I have closely observed the movement of these laborers in the spring from the larger cities to the beet fields throughout the United States. It is as constant and regular as the movement of the wild fowl from the north to the south. I have seen the morning trains carrying out of the city carload after carload of young boys and girls to work in the beet fields. There is no doubt that the sugar factory stimulates the labor supply of its territory. As an evidence of this fact, I offer a few clippings from the press. The Beet Sugar Gazette, of Chicago, May 6, 1907, speaking of laborers going to Fort Dodge, Iowa, where about 200 acres of beets were grown for the factory at Waverly, says:

The Fort Dodge Chronicle reports that a number of experienced sugar-beet growers from Nebraska have arrived and will be put to work on the experimental acreage at Fort Dodge.

The Hastings (Nebr.) Tribune, May 2, 1907, notes the large movement of laborers to the beet fields:

Several Russian-Germans left yesterday and to-day for various beet-growing sections. The major number went to Colorado, but a few were destined to the sugar-beet fields of Kansas and Michigan.

Three special trains carrying beet workers from Lincoln, Omaha, and other eastern towns, were taken west by the Burlington yesterday afternoon. The regular passenger trains also carried a large number of persons bound for the beet fields.

Last night three carloads of workers from this city were taken to Grand Island, from which place they were taken west by the Union Pacific.

It is estimated that 500 persons go annually from Hastings to work in the beet fields. They return late in the fall, some of them as late as December.

The Denver (Colo.) Republican of November 29, 1907, shows the movement of these laborers on their return after the season's work.

Denver and Rio Grande train No. 4, which arrived from the west late last night, had on board about 500 laborers who were returning to their homes in Nebraska from the beet fields near Grand Junction. Each spring these foreign laborers are taken to the beet districts and distributed among the different farmers to be used in the raising of the beet crop.

It is customary in the beet districts to erect temporary barracks or houses to accommodate these laborers during the growing season. These summer quarters for the field laborers may be substantial tents or rough wooden barracks. Throughout the beet districts the

laborers are usually composed of families consisting of father and mother and from three to ten children. It is the custom for the head of the family to contract to do the hand work on the beet farms at a certain price per acre, usually $20 to $22. This labor generally covers the work of bunching and thinning, hoeing, and the hand work connected with the harvesting of the beets.

While for a year or two these laborers may migrate back and forth from a certain locality to the beet fields in which they are working, each year sees more and more of them permanently settled in the vicinity in which the beets are grown. During the summer months they engage in beet growing, and during the other months they engage in other lines of labor connected with agricultural and other industrial occupations. An extract from the Port Huron (Mich.) Times of May 12, 1907, indicates how this takes place:

> Lansing business men have under consideration a plan of colonization of the foreigners who annually visit the vicinity to work in the sugar-beet fields. It is proposed to purchase the lands to be sold in tracts of perhaps 5 acres to the men as an inducement for them to locate permanently there.

As showing the results secured by foreign laborers in a factory district, I quote from the Topeka (Kans.) Capital of May 17, 1907:

> Word has been received in North Topeka from a number of the Russians who have left here during the last few weeks for Garden City, where they have been employed to work in the sugar-beet fields until the crop has been harvested in the fall.
>
> The Russians are being paid an average of about $2 a day for ten hours' labor, while families often contract to cultivate and take care of several acres for a stipulated amount. * * * Several of the persons who have accepted employment in that section this season were employed there last year and returned with more than $100 each and often as much as $200. More than 100 left North Topeka to work near Garden City this summer and others are expected to go in the near future.

The Pueblo (Colo.) Chieftain of March 27, 1907, says:

> We have a proposition from a colony of Japanese to do all the hand work—i. e., thinning, hoeing, and topping—in growing sugar beets for the season of 1907 at $22 an acre flat. They want from 500 to 15,000 acres.

The principal and most difficult work in the beet fields is that accomplished by the hand laborer. Granting that a farmer has at his command sufficient laborers to do this hand work, he is usually prepared through his regular farm help—comprising himself, his sons and his hired hands—to do that part of the work which requires the use of a team. Growing beets very much reduces the team work on the farm, although all the preliminary work of preparing the ground must be done with a team.

The actual time the laborers should devote to growing beets is, to an extent, problematical. The beginning depends largely upon the opening of the season. Planting should be neither hurried nor delayed. Everything depends upon the conditions. The field selected for growing beets should be kept in readiness. This is work that

devolves upon the farmer. When the time arrives the seed should be planted, whether weather conditions indicate an early or late season. The work of seeding is usually accomplished with implements designed for the purpose, but sometimes with small-grain seeders equipped for this work.

Whether the laborers are working by the day or under contract at so much per acre, their work begins after the seed is planted. The beets are often harrowed before they are up and two or three times thereafter. The hand laborer has to deal entirely with keeping out the grass and weeds with a hoe, bunching and thinning, and whatever hand cultivation may be necessary. After the beets are matured and ready for harvest he is required to cut off the tops with a knife and place the beets in piles for delivery to the factory. The division of the work between hand labor and team labor varies with conditions.

LABOR-SAVING IMPLEMENTS AND DEVICES.

Although the beet-sugar industry is new in this country, many improvements, both in methods and machinery, have resulted from American experience and ingenuity.

In the beginning of beet growing in this country we were necessarily compelled to employ the implements and methods in use in older countries. Many of these are well adapted to our use, though it may take us half a century to accustom ourselves to the methods and implements of culture developed through long experience in other countries. At the same time, the American, being progressive, is studying the improvement of these methods and implements.

BEET HARVESTERS.

The harvesting of beets makes a considerable item in the cost of producing the crop. After the beets are grown, they are usually extracted from the soil by means of a long narrow plow with a device for either cutting off or breaking loose the beets and elevating them to some extent. There are several methods of accomplishing this. The idea is to loosen the beets and leave them where the laborer can pick them up, cleave off the tops, and place them in piles ready for delivery to the factory. These implements are called beet pullers. It is readily seen that beet harvesting in this way consists in three different stages of work: (1) Loosening the beets; (2) picking up the loosened beets, cleaving the tops, and removing the dirt; and (3) placing the beets in wagons for delivery to the factory. American inventors are working on a machine designed to perform all three of these things in one operation. At the present time there is a dozen or more different devices adapted to this work. Every year sees better results. Many of these machines will work nicely in certain soils, but

must be improved in order to be adapted to all soils. When a practical machine of this kind is produced we will have done considerable to lower the cost of producing beets. One of the difficulties of harvesting is securing the necessary labor; the more work that can be done by machinery, the more progress we will have made in solving the labor problem and reducing the cost of the work.

TRACTION PLOWS.

The plowing of the ground is usually accomplished with an ordinary stirring plow. It is possible for a man and three good horses to plow from 2 to 3 acres per day. In some districts I note the introduction of a traction plow. The engines used can propel from 12 to 16 gangs and turn over 30 to 50 acres of land per day. They are especially adapted for use on large tracts of ground that are smooth and level. Their especial advantage to the sugar-beet industry lies in the fact that they accomplish a great deal of work in a short time. Sometimes an engine is stationed at either end of the field, so as to draw the plow in either direction by means of cable attachments. In other cases a traction engine moves across the field and drags the gang plows behind it. These traction engines are further used for conveying beets to the factory, drawing from the beet fields a train of wagons attached to each other, loaded with beets. For the purposes indicated, traction engines are destined to play an important part in the future of the beet-sugar industry.

OTHER IMPLEMENTS.

In the eleven years that I have been a close observer of the beet-sugar industry rapid progress has been made in the improvement of all implements having to do with the planting and cultivation of sugar beets. Machines have been designed to sow the seed and at the same time to deposit the commercial fertilizer. We have special wagons, saving time and expense in delivering the beets to the factory. We have special dumps built in the country on the side tracks of the railroads to which the farmers may deliver their beets and have them automatically dumped into cars. If delivered to the factory by wagons, they may be automatically dumped into bins, thus saving time and relieving the farmers of all the hand work of throwing the beets into bins with shovels. Not all beets are delivered to the cars and bins at the present time automatically, but many of them are, and the plans of nearly all new factories now include such conveniences. Some factories which do not have automatic dumps have an arrangement by which beets are taken out of wagons in nets and hoisted to the bins or cars by the use of a crane.

SUGAR-BEET CULTURE.

In my previous reports I have outlined with more or less fullness the general principles underlying beet culture and the methods most successfully employed in growing beets. Since each year sees many new growers entering the field, and my earlier reports are no longer available for distribution, I think it proper to repeat here some of the essentials of sugar-beet culture. It should be remarked also, as an added reason for again presenting this subject, that the methods employed in beet growing are constantly improving as experience points the way to better results. In fact, improved implements and methods of culture are the basis on which the future success of the industry depends.

THE BEET GROWER.

The success of the beet-sugar industry in this country requires definite habits and fixed purposes on the part of the growers. Changeable men with haphazard methods will not succeed with the beet crop. They had better confine their activities to other lines of production. A beet grower must have a clear and definite knowledge of his business. He must have perseverance and the habit of sticking to a line of action once adopted. The culture of this crop must enter into his farming plans for a series of years.

He should study the crop, its culture, and everything connected with it. He should first learn the general facts and principles involved. Having mastered these, he should become an investigator on his own account. He should be a constant observer of the work done and the results secured in his vicinity. He should study the soil on his own farm. While this advice is good for any farmer, it is especially good for the beet grower, for with the beet crop everything depends on intelligent, well-directed action.

If the beet grower is a tenant, it is to his interest to secure a long lease of the ground he tills in order that he may plan his crop rotation and have a deeper interest in the proper treatment of the soil. If the tenant is a farmer of the right sort, long tenancy is to the interest of the landowner as well. Though the soil be ever so well adapted and prepared, to yield best results it must continue for a considerable period in the hands of an experienced, industrious farmer. Extended experience in beet growing tends to give the grower the best ideals of cultivation, fertilization, and crop rotation. Each year he is better equipped to do the work—is a better farmer in all respects.

Studying intensive farming from the standpoint of the beet grower demonstrates that his best interests demand a systematic plan governing his whole work. The beet grower but partly comprehends his resources, if he does not secure all his advantages.

He may rent a farm for a year or two to grow beets, sell them to a sugar factory, and move on to another farm next year; but he is only a partial beneficiary of his business. To gain the highest reward of his calling, his plans should cover a series of years. He should have in mind not only the profits of beet growing, but the accruing benefits of his industry in the improvement of the land and the knowledge and experience he acquires.

The beet-growing farmer should aim to raise the things necessary for the sustenance of his family—milk, butter, eggs, meat, vegetables, grain, etc. His farming should be well balanced as well as systematic.

Except in so far as he voluntarily signs a contract to grow beets for a factory under the counsel and direction of a factory agriculturist, the farmer who becomes a beet grower surrenders none of his independence. At most he has only a little capital invested in special implements, and in many cases no investment of this kind is required. When his contract expires he is entirely at liberty to devote his land to other uses if he prefers to do so. Sugar beets are a cash crop, and the grower does not have to hunt a market. He need not worry about a possible "slump" in the market about harvest time, because the price he is to receive is fixed before he plants the beet seed. If, at the very worst, anything should happen to prevent the delivery of his beets to the factory, he can feed his crop to his farm animals and derive from them a benefit almost, if not quite, as great as if he had sold them for sugar making. In fact the beet grower is more completely "master of the situation" than the farmer engaged in almost any other line of production.

SELECTION OF LAND FOR BEET GROWING.

One of the matters of prime importance with those who contemplate building a beet-sugar factory is the selection of a district having soil adapted to beet culture. But this is not a problem for the beet grower to settle, except so far as he may see fit to engage in preliminary experiments designed to test the soil and climatic conditions. When the factory has been established and the farmer has contracted to grow the beets, the farmer must face the problem in soil selection, and a good deal depends on how he solves it. If he selects a poor or unsuitable plat of ground, he is likely to meet with poor success, and as a result may become discouraged and perhaps permanently prejudiced against beet growing. The prospective grower should select for his first beet crop his best land, considering not only character of soil but conditions as regards tilth and freedom from weeds. The soils should also be well drained. The farmer should bear in mind that the sugar-beet crop is far more expensive to grow than ordinary field crops. The usual

estimate of cost for growing and harvesting beets under rain conditions is $30 per acre; under irrigation, $40 per acre. It will therefore take a yield of 6 to 8 tons merely to pay expenses, while another ton per acre will only give him a fair rental for his land. In order to get good profits he must secure a comparatively large tonnage, and in order to make his crop acceptable to the factory he must grow beets of good quality as regards sugar content and purity. These considerations should guide the farmer in selecting the ground for his beet crop.

The sugar beet is an intensive crop and hence should be planted only on rich, well-cultivated land. It is not a reclamation crop. On account of the thorough and expensive cultivation needed, it should never be made a first crop on new ground or freshly broken sod.

PREPARATION OF THE SEED BED.

In the culture of the sugar beet the land is plowed deeper than for most other crops. If the preceding crop is removed in time, as in the case of small grain, the land should be plowed deep in the fall, and should then be stirred again in the spring. Where beets follow a corn crop which has been gathered from the stalk, the cornstalks must be removed. Then in the spring, after the ground has partially thawed, a disk harrow should be run over the field to cut the stubs and roots to pieces as much as possible, and a hayrake may be used to rake off the loosened stubs and any other trash. It is important to have the ground as clean as possible.

While deep plowing for sugar beets is the rule, care must be taken not to turn up too much new soil in a single year. The depth may be increased year after year until a depth of 10 or 12 inches has been reached. In a new district in 1906, 1,000 acres were planted to beets for the first time. The farmers were advised to plow deep, and most of them did so, many turning over 10 or 11 inches. The advice given these farmers was good in a general way, but bringing to the surface 5 or 6 inches of soil that had never been turned up before was too radical a step. Better results would have been secured if this new soil had been turned up an inch at a time during several years. In 1906, however, a good crop of beets was secured on this deep-plowed ground. But in 1907 corn, potatoes, and other crops did poorly in comparison. Many farmers got the impression that the beet crop had exhausted the soil.

After the ground has been stirred in the spring the soil should be put in a perfectly mellow condition. All clods should be pulverized. The harrow is the principal implement for this work, but it is sometimes advisable to use a roller or a float to crush the clods and then to follow with the harrow.

PLANTING THE SEED.

The beet seed should be planted in thoroughly pulverized soil which is sufficiently moist to germinate the seed. In rain districts planting should follow the spring rains. In irrigation districts the grower should apply water to prepare the soil for planting. From 10 to 20 pounds of seed should be used per acre.

The seed may be planted with a seeder specially designed for the purpose, or a grain seeder may be so adjusted as to perform the work in a satisfactory manner.

The following excellent suggestions appeared in the columns of the Bay City (Mich.) Tribune of May 4, 1907:

Before attempting to sow seed great care should be taken to see that the land is in the best possible condition. See that your seed bed is firm and well pulverized, and that you have at least 3 inches of a loose soil on top. Do not sow your seed until the ground is warm enough to germinate it, as you will get much better results by getting a quick, thrifty germination than by allowing the seed to lie in the ground a long time before germinating.

Do not plant your seed more than 1 inch deep. Poor stands and light tonnage always result from too deep planting. Get your rows as straight as possible, which will be a great help in cultivating.

Use plenty of seed to the acre. We would recommend 20 pounds on 20-inch rows. Do not hurry your drilling. Take time enough to see that all your spouts are feeding so that each row will have a full stand of beets. Drill across at right angles to the way the field was plowed.

It is fair to state that there are some hazards in beet growing. The tender stage of a beet plant is the first two or three weeks after it comes through the ground. An early killing frost may destroy it; a beating rain may crust the ground, making its ultimate recovery difficult; continuous rains may promote a heavy growth of weeds and grass, the removal of which would require so much labor and expense as to be impracticable. In extreme cases it may be necessary to stir the ground again and replant, which is not so bad as a total loss, which often happens with other crops. As it requires only one hundred days or a little more to mature a beet crop, there is considerable range for the planting season. In the Mississippi Valley and the Eastern States beets may be planted from April 1 to June 15. Similar conditions in this respect exist in the intermountain and coast States. Replanting the crop is nearly always possible.

BUNCHING AND THINNING.

Beets should be thinned before or soon after the fourth leaf of the plant appears. This work should be done promptly and effectually. The beet seed-ball contains from one to six germs, each one of which may produce a plant. In their growth the plants from a single seed-ball may intertwine with each other. The sooner the surplus plants

are removed, the better for the plant that is to remain. This work can not be done without disturbing the rootlets of the plant that is left. If the work of thinning is neglected and plants acquire considerable size, the remaining plant will droop, be retarded in its growth, and require two or three weeks to recuperate. With a smaller plant this will not occur.

In order to secure a stand of beets from 10 to 20 pounds of seed per acre is used. Most of the resulting plants are superfluous. The first step in thinning is known as "blocking or bunching." This is done with a hand hoe. One stroke of this implement takes out all the beets in the row for a space of 8 to 10 inches. The distance between the bunches which are left should depend on the width between the rows and other circumstances. Thinning is completed by extracting from each bunch all the plants except one. It takes a quick eye and hand to complete this operation, but it is soon learned by practice. A workman, usually one who is young and active, crawls along the row on his hands and knees, removing the surplus plants in the bunches. He should remove any growing weeds or grass around the remaining plant and press down the loose dirt. This completes the work of bunching and thinning. Much depends upon having this work done at the proper time and in the right way.

Much investigation and experimentation has been devoted to finding a way to do bunching by machinery. The same problem is involved in thinning young cotton plants. Implements have been invented for bunching cotton plants, and are now in successful operation. It is not improbable that implements will be perfected for bunching sugar beets. Some have been devised, but time will be required for their perfection. Bunching and thinning in the growth of the sugar beets consumes time and adds much to the expense. Any implement which reduces the cost will lessen the expense of beet culture.

CULTIVATION.

The term cultivation as here used covers all work done with team and harrow or cultivator to keep the soil of the beet field in a mellow condition and to destroy grass and weeds. This cultivation should begin early. Before planting a spike-tooth harrow should be run over the field one or more times to keep it in good condition and to destroy the early starting weeds and grass. It is sometimes a good plan to thoroughly loosen up the ground with a cultivator, following it with a harrow. It is sometimes advisable to use a "float," or a roller. The harrowing should be continued after the seed is planted to prevent the formation of a crust after rains and to keep down the weeds and grass. Beets may be harrowed two or three times after

they are up without any material injury to the plants. Later the cultivator should be used from three to five times, depending on conditions. The aim should be to do as much team work as possible so as to lessen the amount of hand work, which is more expensive. More or less hand work will be necessary, however, to keep the field clean. This will consist in using the hoe, and pulling such weeds and grass as can not be removed with the hoe.

DRAINAGE.

In a beet field it is just as necessary to remove the excess of moisture as it is for plants to receive a sufficient supply for their growth. The problem of drainage varies greatly, according to conditions. In districts receiving rainfall, the ground may be flat. Precipitation may be more than is necessary for immediate use. In low places the water may stand in pools. This may be followed by a few hot summer days. I have seen areas to the extent of an acre or two absolutely destroyed by what the farmers call "scalding." This may occur even where tile drains have been put in, as has been the case in the beet fields around Fremont, Ohio, and St. Louis, Mich. In these districts a system of surface drainage seems to be advisable. In plowing the land, dead furrows are left from a rod and a half to two rods apart, remaining there throughout the period of cultivation. The surface water naturally runs into these dead furrows, which are connected at the end of the field with an open ditch. Such drainage takes care of an excess of water in a short time.

Excessive moisture on the land retards much of the work of beet culture, prevents cultivation at the proper time, delays the harvest, and naturally increases the cost of the crop. Beet lands should be well drained.

It often happens in the intermountain and coast States, where the soil is watered by irrigation, that alkali salts are brought from the lower depth to the surface. The problem presented here is different from the one requiring surface drainage. Subdrainage becomes a necessity. Such land should be thoroughly tiled. Irrigation water seeping through the soil dissolves the detrimental salts and carries them off permanently through the tile drains.

The large sugar factory at Oxnard, Cal., has a large farm which is quite seriously affected with alkali. The management of this factory, in coöperation with the Government, has been conducting extensive experiments for removing this alkali by the aid of irrigation and subdrainage. The experiments have greatly benefited the land. Through this method a large tract adapted to growing sugar beets and crops of all kinds has been restored to usefulness.

CROP ROTATION AND FERTILIZATION.

Crop rotation and the fertilizing of the soil are matters of great importance in sugar-beet culture. This fact is emphasized by results in the beet districts from year to year.

Every farmer should understand that he can not continuously grow any crop on the same ground and secure maximum results. Many try to do this, but they do it to their own loss and the depletion of the soil. I am often asked if sugar beets as a crop exhaust the soil. This question can not be answered satisfactorily with a plain "yes" or "no." Every farmer should know that plants, of whatever kind, take from the soil some of its plant-food constituents. If the question were "Can I so handle my soil as to grow beets and maintain its fertility?" the answer would be "yes," and the same answer applies to any other field crop. Sugar beets have been grown as a leading crop in many districts of Europe for a long period with increasing productiveness of the soil. This has been accomplished by a system of rotation and fertilization. A similar system must be followed in this country, and considerable progress has already been made in this direction in some of the older beet-growing districts.

One of the great objects of crop rotation is to bring about and maintain an equilibrium of soil constituents and conditions. The best rotation is the one in which the method of culture and action of the plant each year leaves the soil in the best condition for the following crop. It is not my purpose at present to map out definite rotations, but rather to strongly enforce the principle and recommend the adoption of a system of rotation in connection with sugar-beet growing. The crops which should enter into this rotation will differ with the locality and the circumstances. A good rotation for many beet-growing districts will include, in addition to sugar beets, corn, small grain, and a leguminous crop. It is perhaps best to let the beet crop follow either the corn or the small grain.

Sugar beets make heavy demands on the soil, and all soils used in growing this crop should be reenforced to some extent each year. This can be done in three ways: (1) By the application of barnyard manure; (2) by green manuring, and (3) by applying commercial fertilizers. If the soil lacks humus, it must be supplied. Barnyard manure and green crops plowed under are best for this purpose. These are excellent also for increasing the supply of available plant food in the soil. To increase the supply of nitrogen in the soil, crops of legumes may be plowed under. Potash and phosphoric acid may be supplied by commercial fertilizers. The aim should be to keep the land well balanced in its plant-food constituents. Some lands will undoubtedly be benefited by applications of lime to correct an acid condition of the soil and to assist in making the plant food in the soil available. It is usually best to apply barnyard manure with the crop preceding the sugar beets.

STATUS AND CONDITIONS OF THE BEET-SUGAR INDUSTRY IN 1907.

The status of the beet-sugar industry in the different States and the climatic and other conditions prevailing in 1907 are briefly shown here.

BEET-SUGAR PLANTS IN THE UNITED STATES.

The following table gives a complete list of beet-sugar plants in the United States, arranged by States, showing the official names of the manufacturing companies and the locations of the factories. It also shows the daily slicing capacity, expressed in tons of beets, for each factory, the combined daily slicing capacity of the factories in each State, and the aggregate capacity of all the factories in the United States.

Beet-sugar companies and factories of the United States.

CALIFORNIA.

Manufacturing companies.	Factory locations.	Number of factories.	Daily slicing capacity.
			Tons of beets.
Alameda Sugar Co.	Alvarado		800
Los Alamitos Sugar Co.	Los Alamitos		700
Spreckels Sugar Co.	Spreckels		3,000
Union Sugar Co.	Betteravia		600
American Beet Sugar Co., main office 32 Nassau street, New York; Pacific coast office, 604 Mission street, San Francisco.	Chino		900
	Oxnard		2,000
Pacific Sugar Corporation, Los Angeles, Cal.	Visalia		400
Pacific Sugar Construction Co.	Hamilton City		700
Total		8	9,100

COLORADO.

American Beet Sugar Co., 1530 Sixteenth street, Denver, Colo.	Rocky Ford		1,100
	Lamar		600
	Las Animas		700
Holly Sugar Co.	Holly		600
Holly Construction Co.	Swink		1,200
National Sugar Manufacturing Co.	Sugar City		500
The Great Western Sugar Co., general offices Sugar Building, Denver, Colo.	Eaton		600
	Greeley		600
	Loveland		1,200
	New Windsor		600
	Longmont		1,200
	Fort Collins		1,200
	Sterling		600
	Brush		600
	Fort Morgan		600
The Western Sugar and Land Co.	Grand Junction		600
Total		16	12,500

IDAHO.

Utah-Idaho Sugar Co., main office Salt Lake City, Utah.	Idaho Falls		1,200
	Sugar		1,200
	Blackfoot		600
	Nampa		750
Total		4	3,750

Beet-sugar companies and factories of the United States—Continued.

ILLINOIS.

Manufacturing companies.	Factory locations.	Number of factories.	Daily slicing capacity.
			Tons of beets.
Chas. Pope, Chicago, Ill.	Riverdale	1	350

IOWA.

Iowa Sugar Co.	Waverly	1	500

KANSAS.

United States Sugar and Land Co.	Garden City	1	850

MICHIGAN.

Michigan Sugar Co., general offices Saginaw, Mich.	Bay City		600
	Caro		1,200
	Alma		750
	Carrollton		800
	Sebewaing		600
	Croswell		600
West Bay City Sugar Co.	Bay City, West Side		600
Holland Sugar Co.	Holland		350
Owosso Sugar Co., main office Bay City, Mich.	Owosso		1,200
	Lansing		600
German-American Sugar Co.	Bay City, Station A		650
Mt. Clemens Sugar Co.	Mt. Clemens		600
Menominee River Sugar Co.	Menominee		1,200
St. Louis Sugar Co.	St. Louis		600
The Continental Sugar Co., main office Cleveland, Ohio.	Blissfield		600
West Michigan Sugar Co.	Charlevoix		600
Total		16	11,550

MINNESOTA.

Carver County Sugar Co.	Chaska	1	600

MONTANA.

The Great Western Sugar Co.	Billings	1	1,200

NEBRASKA.

American Beet Sugar Co.	Grand Island	1	350

NEW YORK.

Lyons Beet Sugar Refining Co.	Lyons	1	600

OHIO.

Continental Sugar Co.	Fremont	1	400

OREGON.

Amalgamated Sugar Co.	La Grande	1	400

Beet-sugar companies and factories of the United States—Continued.

UTAH.

Manufacturing companies.	Factory locations.	Number of factories.	Daily slicing capacity.
			Tons of beets.
Amalgamated Sugar Co., office Ogden, Utah	Logan		600
	Ogden		400
Lewiston Sugar Co	Lewiston		600
Utah-Idaho Sugar Co., main office Salt Lake City, Utah.	Lehi [a]		1,200
	Garland		1,200
Total		5	4,000

WASHINGTON.

Washington State Sugar Co., main office Spokane, Wash.	Waverly	1	500

WISCONSIN.

Wisconsin Sugar Co., main office Milwaukee, Wis	Menomonee Falls		500
Chippewa Sugar Co., main office Milwaukee, Wis	Chippewa Falls		600
Rock County Sugar Co	Janesville		600
United States Sugar Co	Madison		600
Total		4	2,300
Grand total		63	48,950

[a] Slicing stations at Springville, Spanish Fork, and Provo.

CALIFORNIA.

The beet-sugar industry has been established in California longer than in any other State in the Union. At present there are 8 factories operating: At Alvarado, Los Alamitos, Spreckels, Betteravia, Chino, Oxnard, Visalia, and Hamilton City. There is a large factory at Watsonville, belonging to the Spreckels Sugar Company, which has not been in operation for several years. The one owned by this company at Spreckels is the largest, but one, in the world. This company has devoted its energies to developing beet production for this factory, whose capacity is 3,000 tons of beets per day.

Another factory located at Crockett, belonging to the California Beet and Hawaiian Sugar and Refining Company, operated several years as a beet-sugar factory, when it abandoned production and devoted its energies entirely to refining. Altogether 10 factories have been installed in the State.

Originally most sugar beets were produced in California by rainfall. The beets can be planted much earlier as a rule than in most sections. Sufficient moisture was secured during the rainy season of the winter. The older factories were principally on the coast side. The rain falling in the winter was augmented by subirrigation or underground seepage of water from the mountains to the sea. Throughout these coast valleys the crops have been materially increased by installing deep wells.

The recently built factories of the State are largely dependent upon irrigation from the Sacramento and other inland rivers.

In beet cropping there are some unique features in California. Beets can be planted and produced in different valleys at various times of the season. This lengthens the factory campaigns in some cases to six months. The fact that rain falls in the winter, saturating the soil, while there is unbroken sunshine the rest of the year, gives ideal conditions. The California soil is very retentive of moisture. Conditions are such that beets grown in this State are very high in quality and purity.

The principal beet sections are in the San Joaquin and Sacramento valleys, and the coast region from Mendocino to Chino. In this coast region is the wonderful Salinas Valley, 15 miles wide, estimated to contain about 700,000 acres, 200,000 acres of which are under cultivation.

In the State two new factories were built last year, and one new one is under construction for the campaign of 1908. A number of others are under contemplation.

ALVARADO.—Aside from the heavy rainfall of the winter, which retarded planting to some extent, normal conditions existed in the beet-growing districts adjacent to the Alvarado factory. The factory here is the oldest in operation in the United States. Sugar has been produced at this point regularly for twenty-eight years. The campaign opened September 26 and closed December 9.

BETTERAVIA.—At the Betteravia factory quite a number of improvements were made. Its capacity was largely increased. In this district a fine system of irrigation has been installed. Beets of superior quality and purity are the rule. Fair conditions existed throughout the season. Slicing began the middle of July.

CHINO.—The rainfall of winter in and around the Chino factory was quite heavy. This retarded planting somewhat. The season throughout the rest of the year was quite favorable. The company now owns about 5,000 acres, which very materially promotes a supply of beets. This land has been improved by drainage to remove the excess of rainfall. This expedites preparation of the seed bed at the right time. The average yield of beets was fairly good. The factory began slicing August 26 and closed October 21.

HAMILTON CITY.—The Hamilton City factory, which made its second campaign in 1907, is a 700-ton plant. This factory was built two years ago in a new district, and it illustrates the wonderful developing influence of a beet-sugar plant. The management of this factory conducts its affairs along progressive lines. Much of the ground is broken up by large traction plows. One large traction plow was in use this year which is said to cut 25 furrows at once. Many improvements to promote the work of the beet production and the

manufacture of sugar were installed during the year. A pontoon bridge was built across the river in order to develop a large territory on the other side for beet and general crop production. This facilitated delivery to the factory. The large traction engine is used to deliver beets to the factory, propelling long trains of wagons. The management of the factory has procured a large number of Japanese laborers. Country dumps were installed to accommodate the farmers. The beets grown were of high quality. The factory began slicing September 9 and closed November 9.

LOS ALAMITOS.—The Los Alamitos factory, situated about 30 miles south from Los Angeles on a flat plain, is located near the coast. Most beets furnished for it are grown in its immediate vicinity and around Anaheim. This factory was originally a 400-ton plant. At the beginning, cropping depended upon the full saturation of the soil in winter supplemented by occasional rains during the growing season. This condition has been improved by irrigation from a system of deep wells. During the last few years the capacity of the plant has been practically doubled. For several reasons it has been one of the most successful enterprises in sugar production on the coast. Beets delivered to this factory average the highest in sugar and purity of any in the United States, or in the world, so far as I have record. Last year (1907) the average for the entire campaign was: Sugar, 19.3 per cent with an average purity of 84.8.

I clip from a local paper a list of the averages, covering a period of ten days, of this factory's run from August 31 to September 11, inclusive, which is most remarkable, and probably has never been excelled in the history of beet-sugar production:

Sugar contents and purity of beets grown in southern California, 1907.

Date.	Coefficient of purity.	Percentage of sugar.	Date.	Coefficient of purity.	Percentage of sugar.
August 31	85.4	20.2	September 6	85.7	20.4
September 2	85.8	21.0	September 7	85.8	20.7
September 3	85.7	21.2	September 9	85.1	20.7
September 4	86.2	20.9	September 10	84.9	21.1
September 5	86.1	20.4	September 11	84.8	20.7

From the same paper I also clip an account of the experimental work by a big land-holding company, which shows the development of the district, especially in irrigation, and the draining of land to remove the alkali and excess waters from the overflow of irrigation or excessive rain:

The Bixby Land Company last season put in a 40-acre experimental plat of tile draining and this year it will be increased to 160 acres of alkali land, which formerly was in pasture, being considered unfit for cultivation. The method of operations is, after laying the tiles, to close the outlet and flood the land thoroughly, then open up and let the water which has become alkaline drain off; this operation it repeats time after time until the excess of alkali in the soil has been removed. After this the land

may be irrigated and put into cultivation as any other land. When irrigation water is applied afterwards from artesian wells, the drainage system permits the surplus to drain off and the land is found to be very fertile and productive. The total cost for tiling and labor is said to be from $60 to $70 per acre.

In this district a new device for harvesting beets was in use during the season. It was a combined beet topper, puller, and cleaner. This implement is propelled by two horses. It gave excellent results in this locality. The yield of beets was better than usual. The locality rarely receives an excess of rain in October, but this occurred in 1907, and lowered the general average quality. But for this, the beets would probably have shown over 20 per cent sugar and 85 of purity.

The factory started slicing beets August 15 and closed November 25.

OXNARD.—The Oxnard factory from every standpoint is the ideal factory in the United States. It has a capacity of 2,000 tons, and secures a sufficient supply of beets each year to make a long campaign. The beets are of high quality and purity, and the average tonnage per acre is high. This acreage and quality of beets benefits both the farmers and the factory. The factory has maintained a high record from the beginning. In 1907 climatic conditions were uniformly good, except that heavy rains in the early season retarded the planting and early work. The beets produced during the past season were of unusually high quality. The factory started slicing August 17 and closed November 9.

SPRECKELS.—The Spreckels factory is the most remarkable in many respects of any in the country; principally on account of its size and the development of all conditions that have to do with its wonderful work. It has a capacity of 3,000 tons of beets daily. It is located in one of the largest and most fertile valleys on the coast side of California. It has been the means, more than any other, of influencing and stimulating the improvement of conditions in this large agricultural tract. It consumes 13,000,000 gallons of water in twenty-four hours. Water for irrigation is taken from the river by two centrifugal pumps, having capacities of 10,000,000 gallons in twenty-four hours, each being operated by two large motors. This water is forced through a mile and a half of 32-inch wrought-steel-riveted pipes, and is stored in tanks from which it is taken into the mill by power pumps. Most of the labor on the land in this district is performed by Japanese.

During the earthquake this plant was badly wrecked, requiring a heavy expense to restore it to condition for work during the campaign of 1906. This was accomplished, however, and to-day the plant stands in as good condition as before its injury if not better.

Late rains during the campaign of 1906 interfered with harvesting all the beets. The plant closed before all could be worked. How-

ever, on the opening of the factory several months later for the campaign of 1907, these beets were harvested. They still had sufficient value to compensate the farmers for producing them and the factory for their manufacture into sugar. This illustrates the wonderful adaptation of this section to the beet-sugar industry.

VISALIA.—A factory of 400 tons capacity operated at Visalia its second campaign in 1907. At the time of the installment of this factory conditions were new and much development work was necessary. The management of this factory is meeting all obstacles and will make a record in California. Among the improvements which may be mentioned, the management is installing an automatic dumping system in its beet sheds, bottom-dump railway cars, and special dump wagons. It has also established country dumps along the railway systems which penetrate the district.

COLORADO.

This State heads all others in the development of the beet-sugar industry. It has more wealth invested in the industry than any other. The State is favorably situated, occupying the center of that vast territory west of the Missouri River. It has railroads, mining interests, and general facilities for manufacturing. Agriculture has developed very fast; it has even outstripped mining. The State has wonderfully productive valleys. Stretching from the mountains to its northeast corner is the Platte River, furnishing the water for opening up large tracts of land adapted to agricultural production. In the south, running east from the mountains through the State, is the Arkansas River, supplying irrigation for the development of agricultural resources of all kinds. Running west from the mountains, is the Grand River with its extensive fertile valleys, producing fruit, sugar beets, and other crops.

Outside of the rivers mentioned, there are many fertile valleys drained by smaller streams, carrying water from the deposits of snow and the rainfall in the mountains. In these valleys the sugar industry has taken a firm hold. It has induced the building of large irrigation projects. Other lines of intensive agriculture are following the establishment of the sugar industry. North of Denver in that agricultural section tributary to the Platte River and to the reservoirs for impounding the first drainage of the Rockies are 9 factories at the following places: Eaton, Greeley, Loveland, New Windsor, Longmont, Fort Collins, Sterling, Brush, and Fort Morgan. Along the Arkansas River are 6 factories at the following places: Rocky Ford, Lamar, Las Animas, Holly, Swink, and Sugar City. Along the Grand River in the west is one factory at Grand Junction.

There is hardly a valley anywhere in the State with a sufficient supply of irrigation water that is not under investigation with a view

to establishing the sugar industry. In the well-established districts, land is worth from $200 to $300 per acre.

Colorado averages high in tonnage of beets and without exception beets are of high quality. At the present time, every factory in the State is making a remarkable success of the sugar business. With one exception this has been true of all from the start. The commercial, manufacturing, and agricultural industries of the State have been aided much by the development of the sugar industry. In a few years it has built railroads, towns, and irrigation works. It has rapidly increased the population and wealth, has attracted capital, and built up enterprises that go to make a State great.

The value of the beet crop to the land has been demonstrated by the experience of Colorado farmers, as is shown by the following clipping from a recent issue of the Denver Field and Farm:

> Every observing man must have noticed that the advent of the sugar industry in Colorado has surely had an effervescing effect on land values, and this is one of the most satisfactory features arising from the business. We have seen the land advance in price from $30 or $50 to $200 or $300 an acre, but we must imagine that the latter figure is about the limit, when the earning capacity of a farm is based on its percentage of profit from annual crops. The effect of beet culture has been to bring down the average size of the farms to 20 or 30 acres, but of course we still have many of 100 to 300 in extent. As intensive farming is the rule, however, the ordinary grower finds 20 or 30 acres about all he can manage when put in beets, dependent as he is upon the uncertainties of such labor as may stray along. Another salutary effect has been the improvement in cultural methods, and this is shown tentatively in all other crops. The introduction of alfalfa as a fertilizer to beet lands has proven a great stroke in advancing the science of farming, for the system is gradually coming into use in all other lines of farm production in places where the fertility of the soil is deteriorating.

In the country adjacent to the factories on the Arkansas River the spring was late and there were late frosts. In July there were heavy rains, and in August the weather was exceedingly hot.

In the northern part of the State there was lack of moisture to germinate the seed in the spring, but the balance of the season was favorable.

BRUSH.—The Brush factory of 600 tons capacity made its second campaign in 1907. Considering that it is a new plant, its work may be pronounced very satisfactory.

EATON.—Sugar factory at Eaton, under the management of the Great Western Sugar Company, has been in operation for several years. This is one of the well-developed wheat and potato growing districts of Colorado. As the district is thoroughly equipped with irrigation facilities the factory has been a success from the start. The past year was one of the most successful in its career.

FORT COLLINS.—At Fort Collins is operated one of the largest sugar factories in northern Colorado. It is one of the plants operated by the Great Western Sugar Company. This is the home of the

State Agricultural College and Experiment Station. The district is well developed. Beets yield high tonnage and are of the best quality. Conditions were about normal, and results were favorable.

FORT MORGAN.—At Fort Morgan a new factory has been operated by the Great Western Sugar Company for two years. Beets are grown by irrigation, the water supply coming from the Platte River.

GREELEY.—At Greeley is a plant of 600 tons capacity, the property of the Great Western Sugar Company. This is one of the oldest and best-established agricultural districts in northern Colorado. This plant is one of the best illustrations of the success of a factory resulting from conditions developed prior to its establishment.

GRAND JUNCTION.—At Grand Junction a factory was started in a district almost entirely devoted to fruit culture. It was an innovation. After a struggle for a couple of years, it was closed for two years, then reorganized, and is now one of the most successful in the State.

HOLLY.—At Holly is a factory, built two years ago, beets for which are grown on lands tributary to the Arkansas River. It is near an older factory at Rocky Ford. It has 600 tons capacity. The weather was extremely hot during the latter part of July and the fore part of August. The factory opened its campaign September 23 and closed January 23.

LAMAR.—At Lamar, in the eastern part of the State, along the Arkansas River, is a plant of 600 tons capacity recently removed from Norfolk, Nebr., which made its second campaign in Colorado last year. During the season the weather was not uniformly favorable. The spring was late and cold. Beets were affected by the very hot weather in August, immediately following a heavy rain in the latter part of July. Leaf spot in August affected the crop to a considerable extent and hail disturbed it in a few districts. The pulp and waste molasses from the factory were disposed of to local feeders.

LAS ANIMAS.—At Las Animas is a new factory which operated for the first time in 1907. Beets are grown on lands tributary to and irrigated by the waters of the Arkansas River. It is in the western part of Bent County, about 40 miles west of Lamar. Climatic conditions were not uniformly favorable. The spring was late and cold and frost continued until the middle of May. Heavy rains occurred in the latter part of July, followed by extremely hot weather. A little damage occurred from insects and plant diseases. Leaf spot occurred with damaging effect to both tonnage and quality. Most of the beet pulp is fed to sheep and the waste molasses is sold to a feed-manufacturing company. No pulp is dried. The campaign opened October 11 and closed January 25.

LOVELAND.—At Loveland is a factory of 1,200 tons capacity. It was one of the earliest constructed in the State and was established in one of the well-developed agricultural districts. It is in a region devoted to wheat, potato, and sheep production. The season during the past year, like that in all the other factory districts in the northern part of the State, may be considered quite favorable.

LONGMONT.—At Longmont is another of the northern factories belonging to the Great Western Sugar Company, and it has 600 tons capacity. It has been operating five years. A full supply of beets was received and a full campaign was made. Beets in this district gave good yield and were of excellent quality. The campaign opened September 23 and closed February 1.

ROCKY FORD.—At Rocky Ford is a large plant of 1,100 tons capacity controlled by the American Beet Sugar Company. It is the second oldest and one of the most successful in sugar production in the State. It is about 45 miles east and a little south of Pueblo. Climatic conditions were quite favorable during the season, except the last week in July and the first part of August. There was comparative freedom from insect pests, diseases, hailstorms, and floods.

All beet pulp is used in a fresh state for feed around this factory. The waste molasses is sold to companies which manufacture stock feed. The campaign opened September 16 and closed February 5.

STERLING.—At Sterling is another of the northern factories belonging to the Great Western Sugar Company. It has 600 tons capacity and has been operating two years. It is located in Logan County, near the northeast corner of the State, on lands irrigated by the Platte River. It is on the Union Pacific Railroad, which is crossed at this point by the Burlington and Missouri River Railroad.

SUGAR CITY.—The plant at Sugar City, of 500 tons capacity, was the third factory established in the State. The company controls about 12,000 acres of land and is able to secure all the beets necessary for a full campaign. It is about 17 miles northeast of Rocky Ford. Beets grown around this factory are irrigated by water from Arkansas River. The spring was very cold and backward. This district suffered from a late frost in the middle of May, but the summer was normal and the fall ideal. Taken altogether, the season was quite favorable. No particular disturbances to the growth of the crop occurred except a slight attack of "leaf blight." Most of the pulp produced at this factory is fed locally. No pulp is dried. Most of the adjacent country is devoted to growing sugar beets and alfalfa. Dairying and creamery interests have not been developed yet. The factory opened September 19 and closed January 15, 1908.

SWINK.—At Swink, which is only a short distance from Holly, in the area tributary to the Arkansas River, is located a factory of

1,200 tons capacity. The campaign of 1907 was its second. It had a very large acreage of beets and a very successful season.

NEW WINDSOR.—At New Windsor is located another of the factories belonging to the Great Western Sugar Company. It has a capacity of 600 tons of beets daily. The season was rather favorable and the results secured were satisfactory.

IDAHO.

Idaho is one of the States which has recently assumed importance in beet-sugar production. Throughout the State, in the valleys tributary to rivers and smaller streams in which this State abounds, exist all favorable conditions for agriculture. At the present time irrigation is largely from running streams. The water resources of the State for this purpose are very extensive. Irrigation is in its infancy. For impounding waters in reservoirs conditions are ideal. The Snake River Valley, extending across southern Idaho from east to west and half way up its western border, has been the principal field of irrigation and agricultural development. Beets grown at the present time are upon land tributary to this stream. At the same time many smaller streams draining the mountains offer similar facilities and advantages.

There are now four factories in the State. The first was installed at Idaho Falls five years ago; the second, at Sugar; the third, at Blackfoot, and the fourth at Nampa. All these are along the Snake River. There are many other places in the State well adapted to sugar production, and there is a possibility that other plants will be installed in the near future.

The State of Idaho produces many deciduous fruits adapted to its altitude and climate, such as apples, pears, plums, cherries, small fruit, etc. Idaho is noted for its root crops, and is especially adapted to alfalfa and small grain. Utilization of water for irrigation has hardly begun. The Government Reclamation Service and private enterprises are beginning the storage of waters. In the end this new State will be one of the most important in the Northwest.

The Salt Lake City News of May 4, 1907, gives a fair account of conditions existing in Lincoln County, Idaho:

> Five years ago this district was practically undeveloped. Now it is alive to the development of all its agricultural resources. There are now planted to sugar beets for this factory something over 8,000 acres, with an average yield of 12 tons to the acre. This will give practically 100,000 tons to be harvested and worked up, thereby lengthening the sugar-making campaign nearly one month.
>
> Land around the sugar factory five years ago was offered at from $10 to $25 per acre which to-day is selling readily at from $75 to $100. No crop that is grown by the farmer responds so readily or repays with as much certainty the labor bestowed upon it as does the sugar beet. There is no other crop the farmer can count on as certainly as the sugar beet. He is always able to contract his crop a year ahead at a given price; and, taking all things into consideration, the careful farmer finds that the sugar beet is the most profitable crop he can raise.

IDAHO FALLS.—The Utah-Idaho Sugar Company is operating a factory of 1,200 tons capacity at Idaho Falls. Climatic conditions were not up to normal the past season. There was much moisture in the early spring, and the weather was not warm enough the rest of the year for best results. This district suffered severely from hail-storms. There were no serious attacks of insect pests or plant diseases. In this district during the past season a cultivator working 4 rows at a time was used to good advantage. The pulp from the factory is consumed in fattening sheep and cattle. To a certain extent the waste molasses is fed with the pulp. Farmers in the vicinity are buying more cows to get the advantage of feeding pulp. The factory opened September 30 and closed January 5.

SUGAR.—The Utah-Idaho Sugar Company operated a factory at Sugar with 1,200 tons capacity. The weather in the spring was quite cold, and there was excessive rain. The growing season was rather short, retarding beet development. The tonnage was light on poor soils; on rich soils, good. The management of the factory is actively encouraging thorough fertilization, either by plowing under alfalfa, clover, and other green crops, or spreading barnyard manure and commercial fertilizer. The beets in this district were injured to some extent by a worm which appeared in July and September, destroying considerable beet foliage, thus reducing the tonnage. The pulp produced is used for fattening sheep and cattle, and the molasses also to a considerable extent. Dairying has been considerably increased since the installation of the factory.

BLACKFOOT.—Weather conditions around Blackfoot were not particularly favorable; there was too much moisture and cold weather in the spring and not enough warm weather in the summer. Beets in this district suffered severely from hail. There was no occurrence of insect pests or diseases. Pulp is fed to cattle and sheep. Farmers are greatly increasing the number of milch cows. The factory opened October 12 and closed December 24.

NAMPA.—At Nampa the weather was abnormally cold during April and May, stunting the growth of young beets, especially in poorly prepared soil and late planting. There was some complaint of the "white fly." All pulp produced by this factory is used in feeding cattle, and molasses is mixed with it. The dairying and creamery interests are increasing very fast. The factory opened September 15 and closed November 18.

ILLINOIS.

RIVERDALE.—The State of Illinois recently entered the field of beet-sugar production. Mr. Charles Pope, of Chicago, established a plant of 350 tons capacity at Riverdale, a short distance south of Chicago. On account of the shipping facilities, markets, and favor-

able conditions for growing sugar beets this State is well adapted to this industry. The tonnage of beets is heavy and the quality acceptable for sugar production. Eventually Illinois will be one of the States largely engaged in this industry. The early season was somewhat unfavorable on account of excessive rain. Later the season was favorable. There was no trouble on account of pests, diseases, hailstorms, or floods. The factory dries its own pulp. This product with the waste molasses is all consumed in feeding. The beets grown for this factory during the past year averaged over 15 per cent sugar. This is above the minimum of sugar required by factories.

IOWA.

Iowa is one of the recent additions to the list of States producing beet sugar. From several standpoints the northern half of the State is well adapted to this industry. The soil is rich; crops are sure; beets yield well, and they are of sufficiently good quality to meet the requirements of the sugar factory. This State has a long list of reliable crops. In many parts alfalfa can be grown, and clover is a sure crop in most parts of the State. Stock peas and beans can be grown for reinforcing the soil. Root crops like stock beets, turnips, potatoes, and mangel-wurzels can be produced abundantly. Corn is the principal crop, and small grain is grown generally. With this long list of crops, rotation is easily accomplished. The State is one of the principal producers of live stock. This furnishes the barnyard manure for fertilizing.

As in Minnesota, Illinois, and Ohio, land values are high. The incentive to land speculation does not operate to promote the establishment of factories as it does in connection with the cheap lands of the West. For this reason the sugar industry has not developed in proportion to the favorable agricultural conditions.

This State is crossed by railroads from north to south, from east to west, and diagonally. There is no county in the State without railroads. Many counties are crossed by several. It has many thriving towns. These furnish abundant facilities for transportation of the raw material and finished products and also the market for the sugar and by-products. Every indication points to the northern half of the State as territory that will eventually engage extensively in the beet-sugar industry.

WAVERLY.—A plant was established at Waverly of 400 tons capacity. The season was very unfavorable for all sorts of cropping in this district. This is one of the oldest and best established grain belts in the State, but most crops partially failed last season. Naturally sugar beets were not of the best. I went over the district last fall. While it may be said this crop was not the success desired, yet,

compared with other crops, results were most favorable. It must be considered that this crop was grown by farmers new to the business and conditions were little understood. Yet it gave fair results in comparison with general crop conditions.

The district suffered from excessive rains during most of the growing season. These rains started early in the season. The spring was cold and conditions were entirely unfavorable to planting or starting any crops. It is claimed that such adverse conditions had not existed in the district for twenty-five years. The test of sugar beets under these circumstances was not such as to indicate possibilities. However, there are many things that warrant confidence in the future success of this plant.

KANSAS.

The State of Kansas has been quite thoroughly tested in all parts by private companies, local associations, the Government, and the State experiment station. In the western half of the State, along the Arkansas River, conditions were quite similar to those in Colorado along this stream, where a number of sugar plants have been established. Experiments have demonstrated that there are many places along this stream adapted to the culture of sugar beets and the production of sugar.

GARDEN CITY.—A few years ago the State legislature, to encourage the beet-sugar industry, offered a bounty of $1 a ton for beets grown in the State. Many farmers in the western part grew small acreages and shipped their product to the factories in Colorado. This resulted in the building, in 1906, of a large factory at Garden City, in Finney County. This factory has a capacity of 850 tons of beets per day. This county is penetrated by the Arkansas River. Results at this plant have been so favorable that capitalists have been planning the establishment of three or four others in the vicinity where beets will be grown under similar conditions. The installation of this plant inspired the making of a large irrigation ditch. This has developed a large scope of country devoted to general cropping. It has raised the price of land from $5 to $100 per acre.

The season was not very favorable during the past year. It was cold and dry in the spring, the start of the young plants being thus retarded. During the growing season leaf blight appeared, affecting crops throughout the entire district; also some "crown rot" was in evidence. Two new devices for harvesting sugar beets were tried, but were not entirely successful. The pulp produced at this factory is all fed to stock. This plant has the most modern processes and very little waste molasses is turned out. The capacity of the factory was increased last year from 600 to 850 tons.

MICHIGAN.

In the State of Michigan more beet-sugar factories have been installed than in any other State. The completed list of 22 factories built is as follows:

Full list of beet-sugar factories installed in Michigan, with names, locations, and daily slicing capacities in tons of beets.

	Tons.		Tons.
Bay City (Station A)	650	Croswell	600
Bay City (West Side)	600	Menominee	1,200
Caro	1,200	St. Louis	500
Alma	600	Holland	350
Sebewaing	600	East Tawas	600
Bay City	500	Kalamazoo	500
Bay City	600	Rochester	500
Lansing	600	Benton Harbor	500
Owosso	1,200	Marine City	350
Carrollton	700	Charlevoix	350
Mount Clemens	600	Blissfield	600

While the State is well adapted to this industry, many of these enterprises were immaturely launched. In installing the sugar industry, factories were too closely bunched. It became necessary to remove several of them to other places.

This State has now in active operation 16 factories located as follows: Bay City, Caro, Alma, Carrollton, Sebewaing, Croswell, West Bay City, Holland, Owosso, Lansing, Mount Clemens, Menominee, St. Louis, Blissfield, Charlevoix, and that of the German-American Sugar Company near Bay City. It is fair to presume that the present factories will continue as successful enterprises. Others may be installed with the development of conditions.

The State of Michigan is largely interested in copper and coal mining. A few years ago it was one of the leading States in lumber production. Its railroads and other improvements were based largely upon these. The lumber industry is practically at an end. It has a large area of vacant stump lands, which represent its former business. These lands are cheap, and recently capital has been attracted toward these undeveloped resources.

Transportation lines penetrate the lower peninsula in every direction. It lies near the great commercial centers of the Middle West—Milwaukee, Detroit, Buffalo, Toledo, Cleveland, and Chicago. It is surrounded on the north, east, and west by the Great Lakes, and all these places are accessible from it by water transportation. Michigan probably enjoys the cheapest freight rates of any State in the Union. All this redounds to the benefit of a great industry like sugar making. Considering transportation alone, there is no State better adapted to the sugar industry. The soil also is generally

better adapted. The farmers are developing diversified agriculture, including stock raising, dairying, creameries, fruit growing, and the production of hay, small grain, and root crops. This diversification promotes crop rotation.

Unlike many States in the East, Michigan has large areas of cheap lands offering inducements for speculation and development.

In the growing of sugar beets there are some obstacles in Michigan. There is a liability to early and excessive rains in spring and fall. The first interfere with planting and early cultivation of beets; the last with harvesting, and sometimes they lower the quality of the beets.

At present one of the most pronounced indications favorable to the sugar industry in the State is the tendency of farmers to contract with factories to grow beets. Two or three years ago an insufficient supply was one of the main difficulties, and one which appeared insurmountable, but it has apparently disappeared. In Michigan the factories have nearly all contracted for their entire acreage for 1908 before March 1. Several factory managements refused many contracts from lack of capacity to handle the beets. Taking everything into consideration, the prospects of the sugar industry in the State of Michigan are propitious.

At several of the Michigan factories the beet growers assemble each year at the invitation of the company on what is called "farmers' day." The growers are shown through the plant, and the different steps and processes in the manufacture of sugar are explained. Usually there is a programme of addresses, music, etc. As many as 5,000 persons have attended a single meeting of this kind.

The following from the Saginaw (Mich.) Herald of October 27, 1907, indicates the character of these gatherings:

> The company is arranging to entertain 4,000 to 5,000 beet growers on farmers' day, Saturday. This day has become a big annual event for the beet growers and is a good thing all around. The farmers meet and exchange experiences in the culture of sugar beets and other farm crops and sometimes listen to addresses on sugar-beet culture by experts. It will be remembered that perhaps the most valuable address on this line here was delivered by Secretary of Agriculture Wilson.
>
> The company will use its big warehouse as a banquet hall and here lunches will be served all day to all the visitors. Arrangements are being made for music and speaking. There will be an address of welcome by Mayor Baum and addresses will also be made by other speakers, including probably some of the leading beet growers. On this day all the stations will be closed down and all the company's outside representatives, agriculturists, etc., will be called in to help entertain the farmers at the factory.

Many obstacles were encountered in the first years of the industry in Michigan. The farmers were not educated in beet culture, and, anticipating enormous profits, large acreages were planted by individuals and firms, and bad seasons and difficulty in obtaining labor

to care for and harvest the beets involved heavy losses in some instances. Exaggerated stories of enormous profits in the business caused the people to rush into the construction of sugar factories without due regard for the supply of beets that could be grown in the territory tributary to them. All of these things operated against the industry at the outset. Many farmers declined to engage in the industry after the first two or three seasons, and this forced a number of factories out of the State.

The plants at Benton Harbor and Kalamazoo were taken down and removed to Wisconsin, new companies being formed to operate the same. The Rochester plant was also removed to Wisconsin, the Saginaw to Colorado, and the Michigan Bay City to Waverly, Iowa. Bay City has three factories remaining and in successful operation.

A company was organized and a fine 600-ton plant was erected at East Tawas, but it was only operated one season, the farmers not producing enough beets to sustain it, and it was removed to Chaska, Minn.

Driers have been installed to convert the wet pulp from the factories into dried pulp at Alma, Bay City, and Sebewaing, two of the factories being thus equipped at an expense of nearly $100,000 each. The Owosso plant put in a drying plant last year. During the compaign of 1906, 10,000 tons of dried pulp was produced and baled in Michigan. Shipments have been made to Savannah, Mobile, New Orleans, and other southern points, and to many eastern points. It is confidently expected that, as the merits of this food for live stock become better known, the consumption of it will rapidly increase.

The following figures for the year 1906 will serve to show the magnitude of the beet-sugar industry in Michigan:

In the season of 1906, 30,000 farmers in Michigan raised beets, and 94,000 acres of beets were harvested, producing 800,000 tons of beets.

The campaign of the factories averaged approximately eighty-five days, and the output was 177,000,000 pounds of granulated sugar, or more than the yearly consumption of sugar of all kinds in the State.

In the operation of the factories in Michigan 150,000 tons of coal were consumed, two-thirds of which was produced in Michigan, and 50,000 tons of limestone, all of which was produced in Michigan; also 3,000 tons of coke.

The beet growers in the State were paid $4,000,000 for beets and the value of the sugar produced is estimated at $8,250,000.

The pay roll of the factories averaged over $50,000 for each factory.

The beet-sugar industry has been of immense advantage to the railroads in the sugar-producing districts of the State. During the last campaign the railroads hauled 34,500 cars of sugar beets. The freight bills paid to the roads amounted to $750,000.

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The 94,000 acres of beets raised in the campaign paid to the railroads in freight an average of $8 for each acre harvested.

A comparison of the tonnage of beets with that of other agricultural products explains the excessive amount of freight furnished by beets. An acre of wheat or corn produces approximately 1,000 pounds of freight, while an acre of beets produces 20,000 pounds of freight. The beet-sugar industry has not only furnished the railroads with a vast tonnage, but it has been of great value as a promoter of good roads. Farmers growing beets are naturally concerned in good roads when the period of hauling the beets to the cars or to the factory arrives, and they have used their influence throughout the State to excellent advantage in doing everything that they could to further the construction and maintenance of good roads.

BAY CITY (Michigan Sugar Company).—Within 20 miles of Bay City 6 factories were originally built. Three have been removed. Those remaining are enjoying successful careers. In this district the early season was cold; during August it was too dry. Hail storms occurred in certain localities, doing considerable damage. The Bay City plant of the Michigan Sugar Company has a capacity of 600 tons. It is drying and shipping its pulp. Not much pulp is used locally. Some of the plants in this vicinity, which do not dry their pulp, give it free to the farmers. Eventually, in Michigan, this loss to the sugar industry will cease. The green or dried pulp will have an established permanent market like the sugar product. The plant opened October 19 and closed January 3.

Bay City, Mich., is the real center of thought, inspiration, and enterprise for the beet-sugar industry of the State. The industry in this State is fostered by an association representing the managements of the different factories. Annually a report of the progress and the results of the industry is compiled under the direction of this association.

BAY CITY (West Bay City Sugar Company).—This factory has a slicing capacity of 600 tons of beets daily. The seasonal conditions were the same as those described above.

BAY CITY (German-American Sugar Company).—The German-American Sugar Company also operates a plant of 650 tons capacity near Bay City. The conditions were the same as for the other factories at this place. Wire worms did some damage in beet fields. The factory dries all its pulp and markets it in New York. Waste molasses is sold for the manufacture of alcohol. A new electric-light plant was installed during the season of 1907. The company opened October 23 and closed December 17.

CARO.—The Caro plant is operated by the Michigan Sugar Company. It originally had a capacity of 600 tons of beets daily, but was later enlarged to 1,200 tons. The spring was late; in July and August

it was excessively dry, and there was heavy rainfall in September. During the harvesting months the weather was exceptionally fine. Around this plant wire worms did some damage, and the crops were slightly affected by hail. Farmers consume for feeding all the green pulp, consequently the plant does not dry this by-product. Dairying and creamery interests have been greatly benefited by the pulp output. The campaign opened October 23 and closed December 17.

ALMA.—The plant located at Alma, of 750 tons capacity, also belongs to the Michigan Sugar Company. In the northern part of the territory growing beets for this factory, weather conditions were ideal throughout the season. In the vicinity of the plant and farther south considerable drought prevailed during the latter part of July and August. The season as a whole may be considered an average. There was very little blight, and in a few localities wire worms were active, slightly injuring the crops. There was some damage from hail. This factory dries its pulp and ships it away. The waste molasses is sold and shipped to a company for manufacturing into alcohol. Dairying and creamery interests are developing very fast.

CARROLLTON.—At Carrollton a plant of 800 tons capacity is operating under the Michigan Sugar Company. The early season was late and cold, followed by a dry summer, there being a period of forty-five days without rain. The drought affected the beets. There was some leaf blight. Severe hail did considerable damage, and more was done by wire worms. The factory does not dry its pulp. The farmers use most of the green pulp for feeding their stock. Dairying and creamery interests are developing very fast. The factory opened October 16 and closed January 11.

SEBEWAING.—At Sebewaing is a plant of 600 tons capacity, operating under the management of the Michigan Sugar Company. The early spring was favorable, followed by wet weather after seeding, and extremely dry conditions through July and August. Excessive rains in September tended to increase the tonnage. This was followed by good weather, which improved the quality of the beets. Cut worms were in evidence, also dry rot in the beets, both doing some damage. This factory dries pulp for shipment. Pulp is used locally for feeding cattle. The molasses is partly shipped for alcohol production and partly fed with pulp. The factory opened October 16 and closed January 9.

HOLLAND.—The Holland Sugar Company is operating a plant of 350 tons capacity. As a rule the season was quite wet. Heavy rainfall in the first part of July, followed by excessively hot weather, injured the tap roots. All the molasses produced by the factory is sold for manufacture into alcohol. Only half of the pulp is consumed by farmers for feeding. The factory is not drying its pulp. The campaign opened October 15 and closed December 25.

Owosso.—At Owosso is a plant of 1,200 tons capacity belonging to the Owosso Sugar Company. The early spring was cold and wet, and snow fell up to the 15th of May. The growing season was very dry, but during the harvesting season it was quite wet. This factory dries pulp for the market. A pulp drier was installed last season. Waste molasses is sold for the manufacture of alcohol. The campaign of the factory opened October 16 and closed December 27.

Lansing.—The Owosso Sugar Company is operating a plant at Lansing of 600 tons capacity. The spring was wet, cold, and backward. The summer season was quite dry, and the fall during the harvest season quite wet. No serious injuries were wrought by insect pests, plant diseases, hailstorms, or floods. This plant is drying its pulp and shipping it away. Pulp is not used extensively in the district. The campaign opened October 18 and closed December 12.

Menominee.—The Menominee River Sugar Company is operating a plant at Menominee of 1,200 tons capacity. On account of the cold, wet spring the season started at least three weeks late. It was dry in August, but June and July were favorable. This plant does not dry its pulp. Most of it is either shipped some distance to consumers, or consumed by local farmers for feeding purposes. The factory gives pulp to its own beet growers on demand. Under the influence of pulp feeding, dairying is increasing very fast. The factory installed a new warehouse. The campaign opened October 18 and closed December 3.

St. Louis.—The St. Louis Sugar Company is operating a plant at St. Louis of 600 tons capacity. Rainfall was a little lacking in July and August, which affected the crop to some extent. Wireworms did some damage. This plant does not dry its pulp. About one-half of it is consumed locally. Its waste molasses is sold for alcohol manufacture. The campaign opened October 10 and closed January 15.

Croswell.—At Croswell a plant of 600 tons capacity is operating under the management of the Michigan Sugar Company. The season at this place was favorable in the early spring. May and June were too wet, but it was very dry in August and the first part of September. A very severe hailstorm did considerable damage, and wireworms were also in evidence to a considerable extent. This plant does not dry its pulp, it being consumed by farmers for feeding stock. The campaign opened October 16 and closed December 8.

Charlevoix.—The West Michigan Sugar Company is operating a plant at Charlevoix in the northern part of the southern peninsula. The season was backward in the spring, affecting the vitality of the young plants. The weather during the growing season was quite favorable, but cold and wet during September and a part of October. Grasshoppers destroyed some of the beets. Conditions around this factory are undoubtedly well adapted to beet growing and the beet-sugar industry. But methods different from those employed around

the older factories in the southern part of the State will be required. Agriculture is not so well developed here, but the management of the plant is making strenuous efforts to work out the problems of beet production, and is gradually accomplishing results. This factory does not dry its pulp, it being all consumed locally for feeding purposes.

BLISSFIELD.—This factory of 600 tons capacity was established in 1905 in southeastern Michigan by the Continental Sugar Company, which owns and operates an older factory at Fremont in northwestern Ohio. This plant appears to have started on a very successful career.

MINNESOTA.

Commercially and agriculturally Minnesota is well adapted to beet production and manufacture of sugar. A factory was operated in this State for several years at St. Louis Park near Minneapolis. The plant was installed in the old Wood's Harvester Company's buildings, which were altered to accommodate sugar manufacture. During the career of this plant sufficient beet-producing acreage was developed to furnish a supply of beets. The plant demonstrated the adaptability of the State to the industry. This factory eventually suffered severely from a cyclone, and a little later was destroyed by fire.

CHASKA.—Another factory of 600 tons capacity was established, at Chaska (the machinery having been removed from East Tawas, Mich.), operating for the first time in 1905. Most of the soil used for growing beets for this factory is a sandy loam and produces beets of good quality, also good yields. There are indications that the State will eventually install more plants and occupy an important place in the list of those producing sugar from beets. The season in the farming district producing beets for the Chaska plant last year was cold and wet in the first part; later weather conditions were more favorable. The plant does not dry its pulp, as it is all consumed by the beet growers. The campaign opened October 15 and closed November 27.

MONTANA.

There are many places in Montana where adaptability to the beet-sugar industry has been demonstrated by experiments. Conditions are very similar to those in Colorado. The industry's development must depend upon irrigation. There is a number of valleys whose streams carry an abundance of water available for beet growing and sugar production. It is apparent that the State is destined eventually to occupy an important place in the sugar industry.

BILLINGS.—A plant was established at Billings of 1,200 tons capacity, which was in operation in 1907. The results during the past season may be considered most favorable for the first campaign.

NEBRASKA.

The first factory in Nebraska was installed at Grand Island in 1890 and a second at Norfolk in 1891. These two were followed in 1899 by one at Leavitt. All these were established in the older well-developed agricultural districts in the eastern half of the State. The factories at Grand Island and Leavitt were located near the Platte River, the beets being produced on the sandy-loam soils tributary to this stream. The factory at Norfolk was operated for fifteen years, and was considered a successful business enterprise. But the American Beet Sugar Company, which owned it, secured a lot of lands in the eastern part of Colorado in the vicinity of Lamar, tributary to the Arkansas River, and the plant was removed to this place to develop these lands.

The plant at Leavitt was originally constructed with 500 tons capacity. A few years ago this was increased to 1,100 tons capacity per day. This improvement was made without sufficient capital, the company fell into financial difficulties, passed into the hands of a receiver, and for these reasons it was unable to contract for beets or operate during the past season. The plants at Leavitt and Grand Island have developed a large beet-growing area out in the western part of the State, where beets are grown largely by irrigation. Most of the beets consumed by these two plants for the last three years have been produced in this western semiarid district, irrigated from the Platte River, in Lincoln and adjoining counties. These beets are usually of high quality, and have proven a satisfactory farm crop. A couple of years ago this district produced 11,000 acres for these two factories.

GRAND ISLAND.—On account of the removal of the plant from Norfolk and the stoppage of the one at Leavitt, the plant at Grand Island was the only one operating in the State during the season of 1907. The early season was not favorable for beets. The spring was cold and late, delaying planting. Ideal conditions existed throughout the growing months of the summer. The beet crop matured late in September. This plant does not dry its pulp. The by-product is consumed by local farmers and others in the State. The entire output is sold in advance of its production. The demand for this pulp is increasing very fast. The first few years in the factory's history most of it was thrown away. The plant was opened October 7 and closed December 2.

NEW YORK.

LYONS.—The State of New York has one sugar factory of 600 tons capacity, located at Lyons. There are many things favorable to beet and sugar production in this State. The State has been paying for several years a bounty of $1 per ton upon all beets grown, conditioned on the factory paying $5 per ton on delivery of beets to be worked into

sugar. There are many places in New York adapted to this industry that may eventually be utilized. The State has several advantages. It is near the best markets for sugar. Its transportation facilities, both for the raw material and the finished products, are excellent and freight charges are low. The farmers are in the habit of using by-products adapted to feeding stock, and these bring the highest market price.

I clip from the Geneva (New York) Gazette of March 21, 1907, a table showing some of the best results secured by farmers who produce beets for this factory. These indicate that, under right conditions, good soil planted to sugar beets and properly cultivated will return from $75 to $125 per acre.

Some of the best results secured by New York beet growers.

Name.	Station.	Acres.	Tons of beets.	Returns.
J. R. Maney	Stanley	3	61.15	$305.74
B. Van Gelder	do	5	92.28	461.40
O. Post	Owasco Lake	10	178.90	894.50
C. Young	Weedsport	1	25.37	126.97
C. A. Webster, superintendent of Monroe County penitentiary.	Rochester	20	329.63	1,648.14
I. Budlong	Scottsville	10	173.16	865.43
J. Staat	Spencerport	2	40.93	204.63
John Snyder	Bergen	10	165.93	829.66
E. Wilcox	do	2	40.10	200.48
Frank Lynch	Leroy	6	129.56	647.78
R. Earll	Batavia	5	89.47	447.36
F. Robert	Getzville	2	40.04	200.20

The season was not as favorable in 1907 as in 1906, but a fair crop was produced. During the growing months of summer the weather was exceedingly dry. As a rule, this improves the quality of the beets, and it did so in this case. The weather was quite changeable during October, November, and December. This plant employs about 175 persons during the campaign.

OHIO.

FREMONT.—At Fremont, Ohio, there is a sugar factory of 400 tons daily capacity. There are many things favorable to the beet-sugar industry in this State. The soil is well adapted, the farms are small, and intensive agriculture of all kinds has been developed. Stock breeding and feeding are among the leading features. Dairying and creamery interests are also developed to a considerable extent. The development work of the factory at Fremont is more pronounced than that of any other eastern factory. For several years it was unable to secure sufficient beets for a full campaign, but now sufficient beets are produced in the vicinity of the plant.

In 1905 a plant of 600 tons capacity was established under the same management in the southern part of Michigan at Blissfield in

order to work the beets produced in that district which had been developed by the Fremont factory. These two plants, controlled by the Continental Sugar Company, can, as a matter of fact, secure more contracts than they require. The company has been very seriously considering the establishment of another plant at Defiance or some other place in the beet districts developed. The results during the past season may be considered favorable and fully equal to those of 1906.

OREGON.

LA GRANDE.—In 1898 a plant of 350 tons capacity was established at La Grande. Largely on account of shipping facilities many contemplated projects for extending the beet-sugar industry have not materialized, though there is a number of places in the State well adapted to the industry.

The sugar factory at La Grande is now a successful enterprise. Its management has been patiently working out all those features that have to do with its success. Originally it had many obstacles, principally the indisposition of farmers to grow the beets. By making contracts in new territory it has extended its beet-growing area. The plant is operated under the management of the Amalgamated Sugar Company, with headquarters at Ogden, Utah.

In the early season weather conditions were unfavorable, being too wet. The beet fields were quite free from insect pests and disease. There was little damage from hail storms, but floods prevented some planting. The pulp produced is not dried, but is mostly sold to local farmers, and the waste molasses to eastern feeders. The factory opened October 3 and closed December 15.

A new industry in connection with sugar production is home-grown seed. Up to date we have depended largely upon importations from Germany and France. There is no question but the sugar industry will be greatly benefited when we produce at home our own seed, adapted and acclimated to our own conditions. To grow pure guaranteed seed requires almost as much expenditure as to build and operate a sugar plant. It requires time to develop the sugar-beet-seed industry in this country. Up to date considerable experimentation has been carried on in this direction. It is found that we can grow high-grade seed where proper facilities are maintained for the purpose. Best results are accomplished in the States of Washington, Utah, California, and Michigan. With the introduction of proper facilities no doubt all the sugar-beet-growing area could be utilized in growing beet seed.

I am especially interested in the statement of Judge Rolapp, secretary and treasurer of the Amalgamated Sugar Company, representing

four large sugar factories, whose report I introduce. He especially calls attention to the fact that all the seed used by his company at La Grande, Oreg., is grown in Fairfield, Wash. It should be noted in this connection that for the entire campaign at the La Grande factory sugar contents of the beets averaged over 16 per cent and purity over 84. This is the highest record ever made in the State of Oregon, and was doubtless due more or less to the use of home-grown seed.

I submit Judge Rolapp's report:

OGDEN, UTAH, *July 17, 1907.*

DEAR SIR: I desire to call your attention to the fact that for the first time in the history of the beet industry American-grown seed has been used exclusively for any given factory. This year at La Grande we have planted nothing except seed from Fairfield, Wash. The beets at La Grande are looking well, and from all appearances there will be very satisfactory results. Of course as a moist year this year is abnormal in these mountains, and results will therefore not be an absolute criterion for other years.

Yours, very truly, HENRY H. ROLAPP.

UTAH.

There are four beet-sugar plants in Utah. This State was the third in the Union to engage in this industry, and the development of the industry has been more nearly ideal than in any other. In response to demand from the developed beet-growing areas, plants have been established systematically. Beets are produced principally on irrigated lands, but both rainfall and irrigation are utilized, the amount of irrigation depending upon the extent of the rainfall. Most of the valley lands of the State are adapted to beet growing. Many of the conditions are ideal for this industry. Farms are small, irrigation systems excellent, and the farming class is industrious and frugal. Under existing conditions, in order to secure a maximum of product from a limited acreage, they would naturally adopt an intensive crop like sugar beets.

The streams coming down from the mountains afford water power, which is converted into electricity for lighting, and propelling machinery, trolley cars, etc. The creamery and dairy interests have developed very fast.

In 1905 the beet growers of Utah were very much disturbed on account of the appearance of an insect that did much damage to beets, commonly known as the "white fly." In 1906 Prof. E. D. Ball, entomologist of the State Experiment Station, investigated the work of insects in this section. The results of his work are indicated in the following letter:

COLUMBUS, OHIO, *January 22, 1907.*

DEAR SIR: I spent six months of last year studying the beet insects for the Government, visiting every locality in Utah and western Colorado several times, and

can report that there was practically no damage at all to the beets in the intermountain area. A very few fields were destroyed in Cache Valley, Utah, by flea-beetles in the early spring, but not nearly as many as usual. Wireworms took one small patch at Garland, Utah, and the beet webworm appeared in small numbers in two or three fields. The beet leaf hopper appeared in very small numbers all over the entire region, but did no appreciable damage. Here and there a "curly beet" was seen, but not as many as in an ordinary season.

The only marked effect following last year's damage was that the mother beets which were saved to raise seed from this year were badly affected with the "curly" leaf, and three-fourths of them withered and died, while the rest did not amount to very much. This was evidently the result of last year's injury, because beets alongside of them from this year's seed showed no sign of damage.

Respectfully, E. D. BALL.

LEHI.—There is a factory at Lehi of 1,200 tons capacity, the first established in the State. The season was quite favorable to beet production. The factory has three slicing stations which extract the juice from the beets and pump it through pipe lines to the main plant. These stations are from 12 to 20 miles distant. The factory is not drying its pulp, but wet pulp is fed extensively. This pulp by-product has had considerable influence in promoting stock raising and dairying. The campaign of the plant began September 23 and closed January 18.

GARLAND.—The Utah-Idaho Sugar Company is operating a plant at Garland of 1,200 tons capacity. Normal conditions prevailed throughout the season, and no serious damage was done by plant diseases, insect pests, or hailstorms. No pulp is dried at the factory, the most of it being fed to sheep and cattle. The company is beginning experiments on waste molasses mixed with pulp for feeding purposes. The factory opened October 2 and closed January 5.

LOGAN.—The Amalgamated Sugar Company is operating a sugar plant at Logan of 600 tons capacity. On account of wet weather the early season was not favorable to planting. There was no damage from insect pests or plant diseases. The pulp produced by this factory is sold to farmers for feeding, and molasses is shipped to eastern farmers for feeding.

OGDEN.—At Ogden a plant of 400 tons capacity is operated by the Amalgamated Sugar Company. The early season was not favorable to planting, but it changed for the better during the growing season. The pulp from this factory is sold to local farmers, and the molasses is shipped to eastern feeders. The factory opened its campaign September 12 and closed January 15.

LEWISTON.—The Lewiston Sugar Company is operating a plant at Lewiston of 600 tons capacity. The early season was unfavorable on account of wet weather. During the growing season better condi-

tions prevailed. Some little damage was done by hailstorms and floods. The pulp is used by local farmers for feeding, and molasses is shipped East and used for feeding purposes.

WASHINGTON.

WAVERLY.—A sugar factory was established at Waverly of 500 tons capacity in 1899. There are many other places in the State well adapted to this industry. Up to the present sugar beets have been grown by rainfall. Most of the new projects for building factories involve irrigation. It is probable that some of these will materialize, and that this State will eventually engage more extensively in this industry. Climatic conditions were not favorable during the past season. The management of the plant at Waverly has made strenuous efforts to work out its problems and develop facilities. It has gradually improved conditions, and is now a well-established enterprise.

WISCONSIN.

During recent years there has been a remarkable development of the sugar industry in Wisconsin. Most of the soils in the State will grow sugar beets profitably. The most prevalent type is the clay loam with clay subsoil. Beets grown on this or the sandy loam are usually of high quality and yield well.

There are now in the State four factories. The first was established at Menomonee Falls, followed by others at Janesville, Chippewa Falls, and Madison.

Wisconsin is one of the leading States in creamery and dairy products. The people engage extensively in all kinds of live-stock breeding and feeding. This is very important to the sugar industry, as it furnishes a market for the by-products and maintains soil fertility.

Like Michigan, Wisconsin has an abundance of cheap "stump land," as at one time it was extensively engaged in the production of lumber. The forests have been removed, and something is required to bring the land into usefulness. The sugar industry is adapted to this purpose, and is under special consideration for this end. Railroads, which were needed in the lumber industry, are already established. What is needed now is some new line of agricultural industry which will give these roads freight business.

Especially throughout the Janesville and Madison districts, tobacco has been grown extensively. Tobacco requires as much care and labor as sugar beets. It is not desirable to grow either tobacco or beets on the same ground for many successive years. Both require special and careful tilth, and leave the soil in fine condition for succeeding

crops. It is found in these districts that each of these crops enters nicely into a rotation. When the sugar industry was first installed the tobacco-growing interests were fearful that beet growing would work to the detriment of this crop. Later it developed that the two crops were mutually helpful, and to-day there is harmony between the two interests.

MENOMONEE FALLS.—The Wisconsin Sugar Company is operating a factory of 500 tons capacity at Menomonee Falls, which was established in 1901. The early spring was unfavorable and the summer cold. This factory is not drying its pulp. The green pulp is consumed locally by dairy farmers. This plant has installed the Steffins process for extracting a portion of the sugar contained in the molasses. The campaign opened October 14, closed January 5.

CHIPPEWA FALLS.—The Chippewa Sugar Company is operating a plant at Chippewa Falls of 600 tons capacity. The season of 1907 was unfavorable. The spring was late and wet and the summer rather too cold for growing beets. No pulp is dried at this factory. Most of the product is fed locally to cattle and sheep. The molasses is sold to stock-food manufacturers. Dairying and stock feeding have increased wonderfully since the establishment of the plant. The campaign opened October 21 and closed December 22.

MADISON.—The United States Sugar Company is operating a plant of 600 tons capacity at Madison. The season was not favorable, being rather too wet in the early season and too cold during the growing months. This plant dries its pulp, and it is shipped to consumers. It also has the Steffins process, by which it secures most of the sugar from waste molasses. During the past season the Lyons Saccharate process was installed to work on molasses with a view to securing the sugar contained therein.

JANESVILLE.—A factory of 600 tons capacity was established at Janesville, operating under the Rock County Sugar Company. The season was late, cold, and wet. Most of the beets were planted the latter part of May, some as late as June. During June and July there was a great deal of rain which hindered cultivation in the fields and promoted the growth of weeds and grass. During August and most of September the weather was favorable. In the latter part of September it was cold, retarding the growth of the crop. The beet crop was not damaged by insects or hailstorms. The beets produced gave good tonnage. The average sugar content was 15 per cent and the average purity 84. This factory dries all its pulp, for which it has a good market. It could sell at a profit considerably more than it produces. This dried pulp is shipped to dairy districts, as it is especially

adapted to milk production. In this particular locality the beet tops are quite heavy, and are one of the principal by-products of the sugar industry. The company is now increasing the capacity of the plant, both for sugar producing and storage, preparatory for the next campaign.

STATISTICS OF THE SUGAR INDUSTRY.

Under this heading I include (1) statistical data which I have gathered relating to the beet-sugar industry in the United States; (2) statistics of the world's production of sugar (both cane and beet) as compiled by Willett and Gray; and (3) some miscellaneous sugar statistics.

STATISTICS OF THE BEET-SUGAR INDUSTRY IN THE UNITED STATES.

The acreage planted to sugar beets in the United States in 1907, together with the percentage abandoned owing to unfavorable weather conditions, mistakes of growers, or other causes, is shown in the following table:

TABLE I.—*Acreage planted to beets in 1907.*

State.	Planted.	Abandoned.	State.	Planted.	Abandoned.
	Acres.	*Per ct.*		*Acres.*	*Per ct.*
California	52,823	10.3	Wisconsin	13,800	14.2
Colorado	134,848	5.3	Ten other States	45,197	9.0
Idaho	29,051	10.7			
Michigan	95,302	7.3	The United States	400,953	7.5
Utah	29,932	4.2			

Comparison with the acreage harvested shows that about 30,000 acres, or 7½ per cent, of the acreage planted was abandoned. Comparison with the figures for the preceding year shows that the acreage planted exceeds that for 1906 by 3,338 acres, while the acreage harvested is about 5,000 less, the acreage abandoned in 1906 being only 5.2 per cent. The increased loss of acreage was due mainly to unfavorable spring weather, particularly in Wisconsin, Nebraska, Idaho, and California.

GENERAL FACTORY AND FARM RESULTS.

In collecting and compiling the data which appear in the following table I have followed the same plan as for several years past. The data has been received directly from the factory managements, which are indeed the only source from which authentic statistics of this character can originate. The factory managements this year have

all reported the results of the year's operations with considerable fullness. In a very few cases where the information furnished was incomplete, it has been supplemented by careful estimates. It can be said, however, that the important data are wholly official. To avoid giving publicity to the business affairs of the individual concerns, only totals and averages by States are given for those States having more than one factory, while the results for the ten States each having only a single factory have been thrown together.

TABLE II.—*General factory and farm results.*

BY STATES, FOR 1907.

State.	Factories in operation.	Area harvested.	Average yield of beets per acre.	Beets worked.	Sugar manufactured.		Estimated average extraction of sugar.	Average sugar in beets.	Average purity coefficient of beets.	Average length of campaign.
					Pounds.	Tons.[a]				
		Acres.	*Tons.*[a]	*Tons.*[a]			*P. ct.*	*P. ct.*		*Days.*
California	8	47,387	10.23	484,816	146,045,500	73,023	15.06	17.9	85.1	73
Colorado	16	127,678	11.93	1,523,303	338,573,000	169,286	11.11	15.3	81.5	127
Idaho	4	25,938	9.41	244,080	75,928,200	37,964	15.55	17.8	88.3	88
Michigan	16	88,334	7.89	696,785	169,452,000	84,726	12.16	15.1	84.7	70
Utah	5	28,663	12.32	353,159	88,973,500	44,487	12.60	16.3	86.0	116
Wisconsin	4	11,837	10.37	122,800	30,320,000	15,160	12.35	15.1	85.6	61
States having but a single factory:[b] Illinois, Iowa, Kansas, Minnesota, Montana, Nebraska, New York, Ohio, Oregon, Washington	10	41,147	8.33	342,928	77,964,230	38,982	11.37	15.1	82.3	70
Totals and averages.[c]	63	370,984	10.16	3,767,871	927,256,430	463,628	12.30	15.8	83.6	89

TOTALS AND AVERAGES, BY YEARS, 1901–1906.[d]

		Acres.	*Tons.*[a]	*Tons.*[a]	*Pounds.*	*Tons.*[a]	*P. ct.*	*P. ct.*		*Days.*
1906	63	376,074	11.26	4,236,112	967,224,000	483,612	11.42	14.9	82.2	105
1905	52	307,364	8.67	2,665,913	625,841,228	312,921	11.74	15.3	83.0	77
1904	48	197,784	10.47	2,071,539	484,226,430	242,113	11.69	15.3	83.1	78
1903	49	242,576	8.56	2,076,494	481,209,057	240,604	11.59	[e]15.1	(*f*)	73
1902	46	[g]216,400	8.76	1,895,812	436,811,685	218,406	11.52	[e]14.6	[e]83.3	94
1901	36	175,063	9.63	1,685,689	369,211,733	184,606	10.95	14.8	82.2	88
Averages 1901–1906		252,547	9.66	2,438,593	560,754,027	280,377	11.50	15.0	82.8	86

[a] Tons of 2,000 pounds each.

[b] Grouped together to avoid giving publicity to the data of individual factories.

[c] The average yield of beets per acre is found by dividing the total beets worked by the total acreage harvested; the average extraction by dividing total sugar produced by total beets worked; the average contents of sugar, coefficients of purity, and length of campaigns by adding the figures reported by the different factories and dividing by the number of factories reporting.

[d] Compiled from the annual reports on Progress of the Beet-Sugar Industry in the United States.

[e] These averages are not based on data for all the factories, as some of them failed to report results of tests, but it is believed that they fairly represent the average character of the total beet crops.

[f] No data reported.

[g] Based on reports from 27 factories and careful estimates for 15 others.

If we compare the results for 1907 with the results for any previous year except 1906, or with the six-year averages, it appears that the industry has made an excellent showing, the comparison being in favor of last year in every particular. If, however, we compare the results with those for 1906, it appears that the industry has not quite held its own; but it should be borne in mind that the results achieved in 1906 were remarkable in almost every way. Speaking of these results in my report for last year I said: "The striking feature of the results for 1906 is the immense gain made, the enormous stride taken by the beet-sugar industry. In nearly all respects the year has been a record breaker." The fact that the industry as a whole did nearly as well in 1907 certainly indicates its stability.

The number of factories in operation, 63, is exactly the same as in the preceding year. The decrease in acreage harvested was only 1⅓ per cent, while the acreage planted was, as already stated, slightly greater than in 1906.

YIELD OF BEETS.

The total quantity of beets worked by the factories was 11 per cent less than in 1906, but was 54 per cent greater than the average for six years (1901–1906). The yield of beets averaged 10.16 tons per acre, being exceeded only in two previous seasons—1904 and 1906—and being 5 per cent greater than the six-year average.

QUALITY OF BEETS AND YIELD OF SUGAR.

The amount of sugar produced depends primarily on (1) the quantity of beets worked, (2) the character or quality of the beets, and (3) the extraction of sugar by the factory.

The most remarkable feature of the statistical data for 1907 is the high percentage of sugar in the beets and high purity coefficients. The figures for all previous years have been exceeded. In content of sugar, the highest average for any previous year was 15.3 per cent for 1904 and 1905; the average for six years—1901–1906—was 15 per cent; but the average for 1907 is 15.8 per cent.

The highest average purity coefficient for any previous year was 83.3; the average for the six-year period was 82.8; but the average for 1907 was 83.6. This record is all the more remarkable in view of the fact that the average yield of beets per acre was comparatively high. The effect of this high quality of the beets is shown distinctly in the high yield of sugar. While the total tonnage of beets was 11 per cent less than in 1906, the total sugar produced from the beets was only 4⅛ per cent less than in 1906.

The total quantity of beet sugar produced was 463,628 short tons, this being 67 per cent more than the annual average for the previous six years.

EXTRACTION OF SUGAR.

It is impossible for a sugar factory to secure and transform into marketable sugar all the sugar contained in the beets worked. Hence the percentage extracted is somewhat lower than the percentage which represents the sugar content of the beets, the difference representing the small amount of sugar left in the pulp and the much larger amount that can not be recovered from the molasses. The total loss of sugar ranges from 2½ to 4½ per cent of the weight of the beets, the variation depending somewhat on the purity of the beets, but more largely on the processes used in the factory and efficiency in factory operation.

The percentage of extraction (based on total weight of beets) in 1907 exceeded that of any previous campaign. The highest previous average was 11.74 per cent in 1905; the average for the six-year period (1901–1906) was 11.5 per cent; but the average for last year was 12.3 per cent. While this gain has resulted mainly from the higher average sugar contents of the beets worked, it also indicates increased efficiency in factory operation.

Percentages of extraction are not reported by the factory managements, but are calculated from their reports on tonnage of beets worked and total product of sugar. It is not uncommon for factories to hold over a quantity of molasses which is subjected to improved processes for the recovery of the sugar it contains. In this way it may happen that a considerable quantity of sugar is included in the results of a given campaign which really comes from the beets worked in the preceding campaign. While it is evident that the results of this practice may make the percentage of extraction calculated for certain factories for a given year slightly higher or lower than the actual, it can have no general or permanent effect. It is believed, therefore, that the high general average for 1907 can be accepted as representing the facts.

LENGTH OF CAMPAIGNS.

The period during which a factory is in actual operation is popularly known as the "campaign." The length of a factory's campaign depends, of course, on the total crop of beets and the factory's slicing capacity. The average length of campaign in 1907—eighty-nine days—was greater than in any previous year except 1906, when it was one hundred and five days.

COMPARISON BY STATES.

California, which held first place in the production of sugar in 1902, and second place in 1905 and 1906, fell to third place in 1907, not because of any decided falling off in production, but because of the

industry's growth in other States. In fact the industry appears to be just about holding its own in California. In quality of beets produced the State has always held first place, and this year its lead is more decided than ever. The average percentage of sugar in the beets, 17.9, is remarkable; indeed, a few years ago it would have appeared incredible. But the record made by some of the individual factories is simply phenomenal. In the Los Alamitos district the entire crop as delivered to the factory averaged 19.3 per cent sugar, with an average purity coefficient of nearly 85. In the Betteravia district the sugar content averaged 19 per cent and the purity coefficients 89.1. These records are by far the highest ever made by factory districts in the United States, and it is doubtful if they have ever been equaled in any country of Europe.

Colorado has led all the other States in production of beets and of sugar for several years, and this year its lead is more decided than ever before, its total crop of beets being more than double, and its product of sugar about double, that of Michigan, its nearest rival. In tonnage of beets per acre, Colorado, as usual, stands near the head of the list.

Michigan for several years led all other States in number of factories, and for a time it appeared destined to become the leading State in the development of the industry. In number of factories operated it still leads all States except Colorado, which it equals. In 1907 it held second place in acreage, tonnage of beets, and quantity of sugar produced. In yield of beets per acre it is, however, as it has been for several years, the lowest among the leading beet-growing States.

Utah, with 5 factories, holds fourth place in production, but last year, as in 1906, it led all other States in yield of beets per acre, the average for 1906 being nearly 16 tons per acre harvested, and for the past year 12⅓ tons. In sugar content and purity the beets grown in 1907 were excellent.

Idaho, with 4 factories, though but newly embarked in the industry, has risen to fifth place as a producer of beets and sugar. In sugar content of the beets last year Idaho almost equaled the phenomenal record made by California, and the average coefficient of purity, 88.3, exceeded anything on record in this country.

The results for Wisconsin, which has 4 factories and occupies sixth place, are remarkable only for the high quality of the beets. Small acreage is the evident explanation of the comparatively small production of beets and sugar.

The average results for the 10 States each having a single factory show no remarkable features. It is evident that these factories do not produce on an average as much sugar as the factories in the leading States. The 10 factories worked fewer beets and produced

less sugar in 1907 than 5 factories of Utah. The averages for sugar content, purity, and extraction of sugar, however, are very satisfactory.

PRODUCTION OF BEET SUGAR AND CANE SUGAR COMPARED.

It is interesting to note the progress of the beet-sugar industry as compared with the cane-sugar industry of the United States, as shown in the following table:

TABLE III.—*Production of cane sugar and beet sugar in the United States, 1902–1907.*

[In tons of 2,000 pounds.]

Year.	Cane sugar.	Beet sugar.
1902	368,733	218,406
1903	278,070	240,694
1904	392,000	242,113
1905	383,040	312,921
1906	272,160	453,612
1907	388,640	463,628

With the exception of about 12,000 tons produced annually in Texas, all the cane sugar produced in the United States (exclusive of the insular possessions) is made in Louisiana. While the production of cane sugar appears to be just about holding its own from year to year, the production of beet sugar has considerably more than doubled in six years. In fact the production in 1907 in Colorado alone was almost half as great as the production of cane sugar in Louisiana.

THE WORLD'S PRODUCTION OF SUGAR.

The following table shows the production of sugar in all the sugar-producing regions of the world for the years 1903–1907. The total cane sugar produced is greater than in any previous year except 1906, the falling off in 1907 being 127,000 tons. The total beet sugar produced is less by 227,000 tons than in 1905, and less by 163,000 tons than in 1906. These reductions, both in cane and beet sugar, are trifling compared with the grand total of about 7 million tons produced. The total production falls below that of 1906 by 290,000 tons, or 2 per cent.

TABLE IV.—*Sugar production of the world.*[a]

[Prepared in the Division of Foreign Markets, Bureau of Statistics.]

Country.	1903–4.	1904–5.	1905–6.	1906–7.	1907–8.
CANE SUGAR.					
United States:	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*
Louisiana and Texas	248,277	350,000	342,000	243,000	347,000
Hawaii	328,103	380,576	383,225	3.2,871	420,000
Porto Rico	130,000	145,000	213,000	210,000	217,000
Total United States[b]	706,380	875,576	938,225	845,871	984,000
Cuba	1,040,228	1,163,258	1,178,749	1,427,673	1,200,000
Other West Indies	268,306	244,837	302,163	279,631	291,000
Mexico	107,547	107,038	107,529	108,000	115,000
Central America	21,450	19,768	18,516	19,000	19,000
South America	601,134	590,382	700,001	610,151	586,000
Total America	2,745,045	3,000,859	3,245,183	3,290,326	3,195,000
Asia	2,876,671	3,333,672	2,926,209	3,455,446	3,481,477
Africa	355,747	251,340	317,967	349,000	270,000
Oceania	163,328	216,213	230,000	249,000	276,000
Europe	28,000	18,592	15,722	16,400	11,000
Total cane-sugar production	6,168,791	6,820,676	6,735,081	7,360,172	7,233,477
BEET SUGAR.					
United States	214,825	216,173	279,393	431,796	413,954
Canada	6,710	8,034	11,419	11,367	7,943
Total America	221,535	224,207	290,812	443,163	421,897
Europe:					
Germany	1,927,681	1,598,164	2,415,136	2,238,000	2,135,000
Austria-Hungary	1,167,959	889,373	1,509,870	1,344,000	1,460,000
France	804,308	622,422	1,089,684	756,000	725,000
Russia	1,206,907	953,626	968,000	1,470,000	1,410,000
Belgium	209,811	176,466	328,770	283,000	235,000
Netherlands	123,551	136,551	207,189	181,000	175,000
Other countries	441,116	332,098	415,000	445,000	435,000
Total Europe	5,881,333	4,708,700	6,933,649	6,717,000	6,575,000
Total beet-sugar production	6,102,868	4,932,907	7,224,461	7,160,163	6,996,897
Total cane and beet sugar production	12,271,659	11,753,583	13,959,542	14,520,335	14,230,374

[a] In long tons, of 2,240 pounds, except in the case of European beet-sugar production, which has been retained in metric tons of 2,204.622 pounds, as originally estimated by Licht; United States beet-sugar data were obtained from reports of Department of Agriculture on the Progress of the Beet-Sugar Industry in the United States; other data from official statistics of various countries, and from Willett and Gray.

[b] Not including the Philippine Islands, which are included under Asia.

MISCELLANEOUS SUGAR STATISTICS.

The following tables are made up of data taken mainly from the publications of Willett and Gray.

CONSUMPTION OF SUGAR IN THE UNITED STATES.

The following table shows the quantities of imported sugar (both cane and beet) consumed in this country during the past three years, the quantity of domestic cane, beet, and maple sugars, and the quantities of sugar made in this country from imported molasses. Of the total quantity consumed in 1907, nearly 80 per cent was imported either from foreign countries or the insular possessions of the United States, while less than 13 per cent was domestic beet

sugar. The total annual consumption has nearly reached 3 million long tons.

TABLE V.—*Consumption of sugar in the United States, 1905–1907.*[a]

[According to Willett and Gray, January 9, 1908.]

Kind and origin.	1907.	1906.	1905.
Cane and beet sugar from foreign countries and insular possessions	*Tons.*[a] 2,337,352	*Tons.*[a] 2,281,599	*Tons.*[a] 2,056,092
Cane sugar, Louisiana and Texas	264,968	267,947	334,522
Beet sugar, United States	375,410	300,317	220,722
Maple sugar	10,000	6,000	9,000
Molasses sugar, made in United States from foreign molasses	6,249	8,150	11,880
Total domestic sugar	656,627	582,414	576,124
Total consumption of all sugars	2,993,979	2,864,013	2,632,216

[a] Tons of 2,240 pounds.

The total annual consumption of sugar in the United States, the percentage of increase or decrease year after year, and the per capita consumption for the years 1884–1907 are shown in the table which follows. The total consumption has increased nearly 140 per cent while the per capita consumption has increased over 52 per cent since 1884.

TABLE VI.—*Consumption of sugar in the United States for twenty-four years, 1884–1907.*

[According to Willett and Gray.]

Year.	Total amount sugar consumed.	Increase (+) or decrease (−).[a]	Consumption per capita.	Year.	Total amount sugar consumed.	Increase (+) or decrease (−).[a]	Consumption per capita.
	Tons.[b]	*Per cent.*	*Pounds.*		*Tons.*[b]	*Per cent.*	*Pounds.*
1884	1,252,366	+ 7.01	51.00	1896	1,940,086	−0.49	60.90
1885	1,254,116	+ 0.14	49.95	1897	2,070,978	+6.75	63.50
1886	1,355,809	+ 8.11	52.55	1898	2,002,902	−3.29	60.30
1887	1,392,909	+ 2.74	53.11	1899	2,078,068	+3.75	61.00
1888	1,457,264	+ 4.62	54.23	1900	2,219,847	+6.83	63.60
1889	1,439,701	− 1.21	52.64	1901	2,372,316	+6.87	69.70
1890	1,522,731	+ 5.77	54.56	1902	2,566,108	+8.17	72.80
1891	1,872,400	+22.96	67.46	1903	2,549,642	−0.64	70.90
1892	1,853,370	− 1.02	63.76	1904	2,767,162	+8.53	75.30
1893	1,905,862	+ 2.83	63.83	1905	2,632,216	−4.88	70.50
1894	2,012,714	+ 5.55	66.64	1906	2,864,013	+8.81	76.10
1895	1,949,744	− 3.13	64.23	1907	2,993,979	+4.54	77.54

[a] As compared with the preceding year. [b] Tons of 2,240 pounds.

Although in recent years the beet-sugar industry has made great strides in the United States, and there has been some growth of the cane-sugar industry, the increase in production has not by any means kept pace with the increase in consumption. In fact we are consuming a good deal more foreign sugar than we did ten years ago. In 1897 our total consumption of sugar was 2,070,978 long tons; in 1907 it was 2,993,979 tons, an increase in ten years of 923,000 tons. During the same period the increase in domestic production has been only about 350,000 tons.

SUGAR IMPORTED FOR CONSUMPTION.

The next table shows the character of the sugar imported for consumption, and its origin. Nearly 85 per cent of the sugar imported comes from Hawaii, Porto Rico, the Philippines, and Cuba under tariff concessions, while only about 15 per cent comes from other countries and pays full duty. The imports from both Porto Rico and Cuba are steadily increasing, Cuba alone furnishing about 58 per cent of the foreign sugar consumed in the United States in 1907, and about 45 per cent of the total sugar consumed. It will be noticed that nearly all the imported sugar consumed in the United States is made from cane; in 1906 less than 8 per cent was from beets, and in 1907 less than 1 per cent. In fact if we include the sugar made in the United States, it appears that only about 13 per cent of the sugar we consumed in 1907 was made from beets.

TABLE VII.—*Consumption of imported sugar, 1905–1907.*

[According to Willett and Gray.]

Kind and origin.	1907.	1906.	1905.
Imports on which tariff concession is allowed:[b]	*Tons.*[a]	*Tons.*[a]	*Tons.*[a]
From Hawaii, cane sugar	418,102	343,857	376,497
From Porto Rico, cane sugar	212,853	193,978	124,928
From Philippines, cane sugar	10,700	41,900	14,673
From Cuba, cane sugar	1,340,400	1,165,994	1,101,611
Total	1,982,055	1,745,729	1,617,709
Imports on which full duty is assessed:[c]			
Foreign sugar—			
Raw cane	347,509	357,057	412,560
Raw beet	6,780	175,827	22,161
Refined beet	949	2,734	1,844
Refined cane	59	252	1,818
Total	355,297	535,870	438,383

[a] Tons of 2,240 pounds.
[b] Sugar from Hawaii and Porto Rico is admitted free of duty; that from the Philippines at 25 per cent below the regular rate, and that from Cuba, under the reciprocity treaty, at 20 per cent less than the regular rate.
[c] The regular rates of duty on raw sugar vary from 95 cents to $1.75½ per hundred pounds, depending on the character of the product; the regular rate on refined sugar is $1.95 per hundred pounds.

SUGAR REFINING.

The following table shows that, as a rule, less than 5 per cent of the sugar consumed in the United States is used in a raw or unrefined state, while more than 95 per cent is refined. It also shows that about one-half the refined sugar is turned out by the American Sugar Refining Company, about three-eighths by the independent refineries, about one-tenth by the American beet-sugar factories, and only a small fraction of 1 per cent by the foreign refineries. In fact, owing to the higher rate of duty on imports of refined sugar, practically all the sugar imported comes in the raw state and is refined in this country.

TABLE VIII.—*Consumption of refined and raw sugar in the United States, and quantities of sugar refined by different classes of refiners, 1905–1907.*

[According to Willett and Gray.]

	Quantity of sugar.			Percentage refined.		
	1907.	1906.	1905.	1907.	1906.	1905.
Refined sugar, manufactured by—	*Tons.a*	*Tons.a*	*Tons.a*	*Per cent.*	*Per cent.*	*Per cent.*
American Sugar Refining Co...	1,401,061	1,408,503	1,325,692	49.27	51.03	52.89
Independent refiners	1,064,827	1,031,831	939,557	37.44	37.38	37.48
Beet-sugar factories	375,354	300,059	220,477	13.19	10.87	8.79
Hawaiian cane-sugar factories	1,674	16,964	17,292	.06	.61	.69
Foreign refiners	1,008	2,986	3,662	.04	.11	.15
Total	2,843,928	2,760,343	2,506,680	100.00	100.00	100.00
Sugar consumed in raw state	150,051	103,670	125,536			

[a] Tons of 2,240 pounds.

CONSUMPTION OF SUGAR IN EUROPE.

Mr. F. O. Licht, a high authority on European beet-sugar statistics, in a report dated February 21, 1908, estimates the per capita consumption of sugar in European countries as follows:

TABLE IX.—*European per capita consumption of sugar for the year 1906–7.*

	Pounds.		Pounds.
Germany	40.92	Portugal and Madeira	15.51
Austria	24.32	England	93.50
France	36.05	Bulgaria	7.98
Russia	20.55	Greece	10.16
Holland	41.40	Servia	6.92
Belgium	29.70	Turkey	11.73
Denmark	73.68	Switzerland	55.22
Sweden and Norway	47.88		
Italy	7.63	All Europe	31.61
Roumania	7.83	United States [a]	77.54
Spain	11.37		

The foregoing table shows that we are greater consumers of sugar in the United States than any other nation except England, and that we consume more than two and a half times as much as the people of Europe on an average.

BEET SUGAR PRODUCTION IN EUROPE.

The following is an estimate by Licht of the production of beet sugar in Europe during the last six campaigns:

TABLE X.—*Beet-sugar production in European countries, 1902–3 to 1907–8.*

	1907–8.	1906–7.	1905–6.	1904–5.	1903–4.	1902–3.
	Tons.b	*Tons.b*	*Tons.b*	*Tons.b*	*Tons.b*	*Tons.b*
Germany	2,135,000	2,238,000	2,415,136	1,598,164	1,927,681	1,762,461
Austria	1,460,000	1,344,000	1,509,870	889,373	1,167,959	1,057,692
France	725,000	756,000	1,089,684	622,422	804,308	833,210
Belgium	235,000	253,000	328,770	176,466	209,811	224,080
Holland	175,000	181,000	207,189	136,551	123,551	102,411
Russia	1,410,000	1,470,000	968,000	953,626	1,206,907	1,256,311
Other countries	435,000	445,000	415,000	332,098	441,116	325,062
Total	6,575,000	6,717,000	6,933,649	4,708,758	5,881,333	5,561,257

[a] According to Willett and Gray. [b] Tons of 2,240 pounds.

The foregoing table shows the enormous proportions to which the beet-sugar industry has developed throughout central Europe and especially in Germany, Austria, and Russia. Though, as already stated, cane sugar heavily predominates in the consumption of America, exactly the reverse is true in Europe.

DEVELOPMENT OF CONDITIONS AND PROSPECTS FOR EXTENDING THE BEET-SUGAR INDUSTRY.

CALIFORNIA.

There are a number of places in California where conditions are favorable for the establishment of the beet-sugar industry.

CORCORAN.—At Corcoran a 600-ton plant is under construction. Beets will be grown for its first campaign in 1908.

EL CENTRO.—A large company, known as the Imperial Sugar Company, capitalized for $3,000,000, is planning to erect an 800-ton plant at El Centro, in San Diego County.

SANTA ANA.—There is a project under headway for establishing a sugar factory at Santa Ana of 500 tons capacity, and its consummation appears probable.

COLORADO.

BERTHOUD.—A factory is under contemplation at Berthoud with a capacity of 750 tons. The following letter outlines the conditions and prospects at that place:

BERTHOUD, COLO., *July 15, 1907.*

DEAR SIR: We have secured contracts for the growing of 6,000 acres of beets for five years at $5 per ton. This acreage can be increased if necessary. We have an ample supply of water for irrigation, and our town has recently installed a complete waterworks system, furnishing an abundance of filtered water.

Our farmers are expert beet raisers, having grown beets for the last seven years, which have been sold to the Great Western Sugar Company. This company is unable to erect sufficient factories to handle the beet crop. Our farmers desire to raise more beets, as they find it a profitable crop. We have raised as high as 35 tons to the acre, and a 20-ton average is no unusual thing. We desire to interest capital in our project.

Respectfully,

D. M. MAY,
President Berthoud Beet Growers' Association.

DELTA.—With reference to a project now under consideration at Delta, I clip the following from the Glenwood Springs (Colo.) Post of March 14, 1908:

A Delta dispatch Friday night says: News reached here by telegram from New York this afternoon that Delta is to have one of the finest sugar factories in the State of Colorado. It will cost nearly $1,500,000 and is to be built by New York, St. Louis, and Kansas City capital.

The Business Men's Association has been working hard for the factory, and the message to-day states that its efforts have not been in vain. The company back of the affair is known as the Surety Sugar and Land Irrigation Company, and the tele-

gram states that the company has put up its $100,000 bond as a guaranty that the project will be carried out.

The company is incorporated for $2,500,000, divided into 25,000 shares of $100 a share. Work will be started soon, and the factory is expected to be completed within about a year.

Delta has pledged a 50-acre location for the factory and must take $100,000 of the capital stock. Six thousand acres of sugar beets have been pledged. This company agrees to pay a flat rate of $5 a ton for beets for three years.

JULESBURG.—Sugar beets have been grown quite extensively for several years in the vicinity of Julesburg. Conditions have been pretty thoroughly determined at this place. It has excellent facilities, and everything appears favorable for installing the sugar industry.

I insert a copy of a letter from Mr. Mark Burke, who has given the subject of sugar beets considerable attention and has made many yearly reports with reference to the prospects at this place:

JULESBURG, COLO., *February 15, 1908.*

DEAR SIR: We have grown beets successfully for five years. Tonnage ranges from 10 to 18 tons per acre. We never could get a test of the beets except once (from American Sugar Company), and then they showed over 18 per cent sugar.

We have 28,000 acres of good beet land under a storage reservoir, the capacity of which is 1,230,000,000 cubic feet, three large ditches for distribution, and a source of water supply that can never fail. There are two lines of railroad through the district, with facilities for loading at a distance not greater than 4 miles from any land in the district. We can guarantee to supply a 1,200-ton factory for five years, beginning with 1909. Farmers would be glad to raise beets if we had a factory here, but are tired of waiting for cars in the fall to ship to other factories.

Yours, truly, MARK BURKE.

FOUNTAIN.—I insert a report made by Edward Van Asmus with reference to conditions near Fountain. A sugar factory has been under contemplation for some time, and conditions there are well adapted for the industry:

FOUNTAIN, COLO., *March 3, 1908.*

DEAR SIR: Replying to your favor of the 13th ultimo, we had about twenty-five different growers of sugar beets this year. The area amounted to about 400 acres. The average yield was 14 tons. All the beets were contracted and sold to the sugar factory located at Swink, Colo.

Our prospects for a sugar factory are such that we can have one any time we wish it.

Yours, truly,

EDWARD VAN ASMUS.

MONTROSE.—Montrose has been considered a favorable locality for building a sugar factory. Its conditions are well adapted to the sugar industry. A considerable acreage of beets has been grown here for the factory at Grand Junction, Colo. The prospects for establishing a factory at this point in the near future appear quite favorable. The following letter is from the president of the commercial association organized at this place:

MONTROSE, COLO., *February 22, 1908.*

DEAR SIR: The prospects for building a sugar factory at Montrose are fair, but, while we make a splendid showing in both beets and percentage of sugar, our acreage is but

about 1,000 as yet. At present our farmers are shipping to the plant at Grand Junction, 73 miles distant, and getting a flat rate of $5 on board cars here.

Our tonnage last year averaged 17½ to the acre. The sugar content was an average of 16½ per cent. The purity is between 90 and 94, but I have not the average figures from the factory. Individual areas yielded 20, 25, and 30 tons, and in one instance three-fourths of an acre, measured by disinterested parties, yielded at the rate of 37½ tons to the acre. Sugar content has run up to 22 and in one sample to 24 per cent.

Under the Gunnison tunnel, now being constructed by the Government to divert the waters of the Gunnison River into the Uncompahgre Valley, the outlet being near Montrose, there are, by Government survey, 150,000 acres of fine fertile soil, all of which is rich beet land, though much of it is the best orchard land in the world and therefore too costly for beet culture. This tunnel will be completed in one year and will water the entire valley. At present the acreage cultivated is but 30,000, and the water supply is from the Uncompahgre, but not sufficient even for the present acreage.

It is my opinion that, when the Gunnison tunnel, or "Uncompahgre project," as the Government calls it, is completed, there will be two sugar factories in Montrose County—one at Olathe and one at Montrose—as both localities are fine for beets.

We have several kinds of soil contiguous to Montrose: (1) The adobe soil, which is rich and very lasting, but hard to conquer; (2) the red or chocolate soil, the best fruit land known, also fine for beets; and (3) the gravel and sand loams of the river bottoms and slopes, which grows great yields of beets.

The average beet crop here brings the producer $90 per acre on the cars. Russian labor tills, waters, thins, and looks after the crop for $20 an acre, if desired. So the farmer plants the crop and then harvests it and hauls it to the cars as his share, and averages $70 an acre for his labor and land income.

Very truly, O. C. SKINNER.

OTHER PLACES.—Among other places mentioned in connection with the establishment of beet-sugar plants are Ault, Hillrose, Pueblo, Manzanola, and Wiley; and another factory at Holly is proposed.

IDAHO.

A number of places in Idaho have been thoroughly tested. This has been accomplished in the most practical way by growing beets for other factories in the State.

PAYETTE.—Everything indicates that a factory of 600 tons capacity will be built at Payette. This district has grown a large acreage for the factory at Nampa. The yield is good and the beets of high quality. It is said that the Utah-Idaho Sugar Company is under contract with local business men to build a factory at Payette for the campaign of 1908.

I insert here a letter from William McOmie in regard to conditions and prospects at this place:

PAYETTE, IDAHO, *March 7, 1908.*

DEAR SIR: Your letter reached me yesterday. I have charge of the agricultural work here for the sugar company. I will say there was 1,800 acres planted in what we call the Payette district in 1906, which lies on either side of the Snake River, partly in Idaho and partly in Oregon. The crop did so well and the farmers were so well satisfied that 4,400 acres were planted in 1907.

The two years were just the reverse of each other. In 1906 we had a very warm, wet spring and summer. In 1907 it was very cold and dry. Getting the reverse in climatic conditions, and the beets doing well both seasons where the soil was handled right, proves beyond all doubt the success of the industry in the Payette Valley.

There were many growers who realized $70 per acre net in 1906, and several who cleared above all expenses, in 1907, $40. But last year was much more unfavorable in the spring for starting the young plants, and unless a grower had his soil well fertilized and the moisture well protected he did not realize as he did when nature supplied what was needed the year before.

The sugar content was fairly good, though not as good as it would have been had not so many of the young plants been stunted. The average percentage of sugar in the beet would be about 14 per cent with a purity of 83.

As to the cost of production, it largely depends on the way the grower manages his business. The hand labor cost is $20 per acre for an average tonnage of 12 tons. This includes blocking and thinning, hoeing, pulling, topping, and loading into the wagons during the season. This work was largely done by Japanese. The team work or the labor done by the farmer will vary from $10 to $15 per acre, about $12.50 being an average.

The people of Payette Valley want a factory and will undoubtedly get one before very long. In fact, our company has promised to build just as soon as conditions will justify.

The average tonnage last year at this point was 9 tons to the acre; in 1906 it was over 12.

Very respectfully, WM. MCOMIE.

BOISÉ.—Capitalists have under consideration the construction of a factory at Boise, the State capital.

ILLINOIS.

ELGIN.—Business men and capitalists of Elgin have been considering the sugar industry during the past season, as is shown by the following letter.

ELGIN, ILL., *February 19, 1908.*

DEAR SIR: We have the assurance, that of a reliable concern, to put up a sugar plant at this place, providing the farmers in the locality will agree to raise at least 3,000 acres of sugar beets. The industry is new in this locality, last year being the first that sugar beets were raised. There were about 250 acres planted. The yields were from 12 to 20 tons per acre. The sugar contents ran from 14½ to 17½ per cent, with a very high purity.

Very respectfully, C. G. HEINE.

IOWA.

There are many places in this State well adapted to the sugar industry. During the past season in the vicinity of Fort Dodge about 200 acres of beets were grown for the factory at Waverly. These were grown under the direction of an expert. The season was very unfavorable for any crops on account of the excessive rain. Sugar beets, like other crops, suffered from the unfavorable climatic conditions, but in comparison the beet crop held its own. Fort Dodge and Waterloo are situated close enough to Waverly to be influenced by conditions developed by the factory at this point.

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KANSAS.

There are a number of places in the vicinity of Garden City where the advisability of establishing a beet-sugar plant is under consideration. It is said that the company operating the factory at Garden City has in view the development of sufficient lands along the same irrigation ditch to enable them to install four more plants. It is apparent that other plants will be installed in Kansas in the near future.

MICHIGAN.

There are a number of places in Michigan where the building of sugar factories is under consideration.

MOUNT PLEASANT.—Some time ago a plant was started at Mount Pleasant. Work ceased before it was completed. It seems quite probable now that this plant will be completed for the campaign of 1908.

MONTANA.

The sugar industry has played an important part in developing agricultural conditions in Montana. It has been an incentive to establishing irrigation facilities. There are many places in the State adapted to this industry.

BOZEMAN.—The Bozeman district has been very carefully investigated by a number of persons interested in the sugar industry. This place is the home of the agricultural college and the State experiment station, and conditions are well adapted to this industry.

With reference to conditions and the prospect of building sugar plants, I submit a report from E. S. Edsall, secretary of the Gallatin Valley Commercial Club at Bozeman:

BOZEMAN, MONT., *February 8, 1908.*

DEAR SIR: As to the prospects of building a sugar factory in the Gallatin Valley, I regret to say that just at this time the outlook is not encouraging. This project was taken up about two years ago for the first time, and after much work on the part of the parties having it in charge the acreage asked for by the syndicate was finally secured in the fall of 1906 or spring of 1907. They asked for 5,000 acres, and it was a hard matter to secure this amount within hauling distance of the proposed site, and the farmers were, of course, a little backward about undertaking it as a new proposition. However, the acreage was finally secured. The committee making this canvass, however, had promised the farmers that their contracts would not be surrendered to the sugar company until all arrangements had been made for the importation of the proper kind and amount of labor for cultivating and harvesting the beets. Laborers at that time were at a premium in this valley, and especially the kind of people required for this work. In spite of the fact that every available means was used to obtain labor, nothing could be guaranteed to the farmers, and the local promoters, having given their word in this matter, did not feel like releasing the contracts under these conditions. The matter was dropped after many trips east, west, and south in an effort to secure labor.

Yours, truly,

E. S. EDSALL, *Secretary.*

The following letter is from the director of the State agricultural experiment station:

BOZEMAN, MONT., *February 24, 1908.*

DEAR SIR: A little over a year ago considerable was done in this valley in the way of working up an interest in the sugar-beet question, and also in regard to the establishment of a beet-sugar factory in this valley. However, because of the inability to get the necessary laborers to do the hand work in connection with the sugar beets, the matter was dropped for the time being.

Another factory is being arranged for and I believe will be built in the northern part of the State, in the Milk River Valley, near the town of Harlem. It is expected that considerable of the beets for this factory will be grown on the Indian reservation.

The factory at Billings, which has a daily capacity of 1,200 tons, has completed a very successful second season, handling in the neighborhood of 9,000 acres of beets.

Very truly, yours,

F. B. LINFIELD.

CHINOOK.—The business men and farmers in the vicinity of Chinook have been very energetic for three or four years in promoting a beet-sugar factory. Some of the leading capitalists of the country who are interested in the sugar industry have given the place close investigation.

I submit a communication from A. W. Ziebarth, secretary and treasurer of the Beet Growers' Association of Chinook; also a table showing the sugar content and purity of beets that have been produced in the district:

CHINOOK, MONT., *February 21, 1908.*

DEAR SIR: The prospects are very good that the factory will be built and in operation for the season of 1909.

Beets have been grown experimentally for the past five years by a great many farmers in tracts of one-fourth to one-half acre.

I inclose a report of some analyses made during the past years and, in explanation of the sugar content of some of the samples, I wish to say that I believe the small percentage of sugar is due to the fact that these beets were pulled before fully matured.

Last season I had five samples analyzed: Nos. 3959, 3967, 3956, and 3980, and was careful to see that they were fully matured, and the result shows an average sugar content of 19.88 per cent and an average purity of 83.69.

We have very little information on tonnage, as no record was made except in a few instances where a tonnage of 21 to 23 tons per acre was raised.

We have about 30,000 acres of land under irrigation between Yantic, 10 miles west of Chinook, and Harlem, 20 miles east, all lying within easy hauling distance from the railroad. About three-fourths of this land is a sandy loam, the soil having a depth of 10 to 15 feet, and it is good sugar-beet land. The balance is rather heavy, being a gumbo. The source of irrigation is from Milk River and its tributaries.

Yours, truly,

A. W. ZIEBARTH.

Analyses of samples of sugar beets from Chinook, Mont.

ANALYSES MADE AT MONTANA EXPERIMENT STATION, BOZEMAN.

Lab. No.	Grower.	Average weight of beets.	Sugar in beets.	Coefficient of purity.	Condition.
		Ounces.	*Per cent.*		
781	O. R. Thornber	46.00	15.58	84.01	
782	O. R. Thornber	47.00	12.16	75.04	
2978	R. H. Clarkson	28.50	12.03	73.04	Good.
3391	W. O. Smotherman	21.00	16.63	84.01	Good.
3412	W. W. Cook	20.00	16.09	85.06	Good.
3413	W. W. Cook	68.00	10.62	73.03	Good.
3430	W. B. Sands	25.00	18.05	89.07	Wilted.
3441	R. H. Clarkson	21.05	18.06	90.04	Wilted.
3443	W. B. Sands	18.00	15.58	87.07	Good.
3450	Mrs. R. F. Morris	35.50	12.00	69.05	Wilted.
3462	John Clark	28.05	20.04	90.07	Good.
3463	Gust Stevens	11.06	19.07	92.01	Wilted.
3464	W. O. Smotherman	18.04	19.86	88.03	Good.
3465	A. H. Reser	64.03	14.02	84.02	Wilted.
3957	John Luse	40.00	16.40	80.80	
3967	John Clark	16.00	23.00	88.60	Wilted.
3965	W. B. Sands	34.67	20.90	84.90	
3956	W. D. Smotherman	26.67	20.60	87.10	
3960	J. J. Hallenberger	33.33	18.50	77.08	

ANALYSES MADE AT OGDEN, UTAH.

.....	R. H. Clarkson	.....	17.00	82.20	
.....	Maurice Jones	.....	16.00	82.70	
.....	Henry Bosch	.....	13.40	81.10	
.....	W. B. Sands	.....	16.00	86.80	
.....	R. Hermes	.....	13.20	82.50	
.....	John Prosser	.....	14.20	81.30	
.....	John Clark	.....	16.20	83.00	
.....	W. D. Smotherman	.....	16.00	80.00	

At Chinook, local interests have subscribed over $7,000 to carry on investigations and experiments. A local association has secured contracts from farmers to grow 3,000 acres of beets.

The average sugar content of beets grown in the locality last year was 16 per cent and the average purity coefficient 83. Irrigation has been developed to a considerable extent. Investments in these improvements are largely made by local landowners and farmers. The Winter-Anderson ditch supplies 2,000 acres; the Paradise ditch, 5,000 acres; the Harlem Ditch Company, 10,000 acres; the North Fork of the Milk River furnishes 10,000 acres. Chinook is in Chouteau County, and has been the center of a great cattle-grazing district.

CONRAD.—Another point under special investigation for some time is Conrad. The American Sugar Company, controlled by the Havemeyers, is interested to a considerable extent in Colorado. It represents the principal interest in the factory at Billings, and has been investigating conditions at Conrad.

HARLEM.—Harlem seems to have an excellent prospect for a factory. It is situated in Chouteau County, just outside of the Indian reservation, and within 3 miles of the Northern Pacific Railroad. A

spur will be built to this place to accommodate the factory. Local interests and capitalists have been working on this project for some time. It is the plan to use the Indians on the Fort Belknap Reservation as laborers to cultivate the beets. A special act of Congress was passed to carry through this project. Recently the principal investors in the Amalgamated Sugar Company of Utah, acting under the provisions of this new law, entered into a contract with the Government to lease 10,000 acres of Indian lands in this reservation.

I clip from the Salt Lake City (Utah) News of January 10, 1908, an account of the movement for establishing this plant at Harlem:

OGDEN, *January 10.*—A gigantic enterprise will soon be launched by Ogden capitalists, involving the building of a $1,000,000 sugar factory on the borders of the Fort Belknap Indian Reservation near the town of Harlem, in northern Montana.

After three years investigation and negotiation, aided by a special act of Congress, a contract for a lease was signed yesterday in this city.

The agreement, which is a lease of 10,000 acres of tribal lands in the Fort Belknap Reservation for a period of ten years, involves the outlay of $1,000,000 on a sugar plant immediately outside of the reservation, the construction of a three-mile railroad line and the inauguration of a system of irrigation starting from the Milk River, a stream that runs through the Indians' land and to the water of which they have prior claims. Work on the factory will be commenced in the fall, so that the factory will be completed for use in 1909, when the first crop of sugar beets is to be harvested by the Indians.

The educational value of the project can not be estimated until after a thorough test has been made, but it is a splendid chance for 1,400 healthy Indians.

The 10,000 acres of land to be used in the growing of beets lie in a very fertile valley within the Indian reservation, immediately joining the town of Harlem on the south.

I also submit a special report from W. E. French, of that place, giving further facts in relation to the establishment of this plant:

HARLEM, MONT., *February 4, 1908.*

DEAR SIR: The crop of beets is to be grown by the Indians in so far as they are capable, and in the event of their inability, the sugar company has the privilege of supplying other contract labor; but in any event the sugar company is compelled to pay for the crop at the rate of $4.50 per ton, the Indians receiving the entire benefit, less the expense of growing.

The contract for the erection of the factory will be let this summer and a start toward the building will be made this fall. The factory will be ready to receive the crop in 1909. The capacity of the factory will be 600 tons, but the machinery to be installed will be of sufficient capacity to allow double this tonnage.

The exact location of the factory has not as yet been decided, but it will be built within a radius of 3 to 12 miles east of Harlem, on Milk River.

While the sugar company is working the Indian lands, giving employment to many and acting somewhat as a school of instruction in sugar-beet culture, the white people will settle up by location and purchase those lands tributary to this reservation, and in due time, and after the expiration of this contract, will be able to supply the factory with all the beets it can handle.

Our soil is generally of the sandy loam nature and is considered a first-class soil for sugar beets.

Very truly, yours, W. E. FRENCH.

Further facts relating to conditions around Harlem are given in a letter from Thomas M. Everett:

HARLEM, MONT., *March 23, 1908.*

DEAR SIR: We have experimented very little in the raising of sugar beets; that is, we have not raised them in large quantities, but from the small patches planted for the last four years the results have been very flattering, one sample going as high as 28 per cent sugar with a purity of about 90. This sample was analyzed at our State fair by the chemist of the State Agricultural College and was, I believe, the best ever tested in the State. A few acres have made as high as 30 tons per acre; of course this is not an average, but the best I have heard of. I think the average yield has been about 20 tons of beets, with an average purity of about 90 and an average sugar content of about 17 per cent.

The soil of the Milk River Valley, in which we are located, is a very deep, dark soil, containing considerable sand, but much of it is what would be called gumbo, in which all root crops grow to perfection.

It has been thoroughly examined by the experts of the Amalgamated Sugar Company of Utah, who are going to build the factory, and they seem to have no doubt of its fitness for the sugar beet.

Yours, very truly, THOS. M. EVERETT.

DILLON.—The most recent proposition for a new sugar factory in Montana is at Dillon. Mr. Louis Penwell, of Helena, who is one of the principal owners of the Beaverhead Ranch Company, purchased the big Morris ranch, on Birch Creek. He is planning to cut up this ranch into small tracts, introduce settlers, and establish a beet-sugar factory.

NEBRASKA.

NORTH PLATTE.—At North Platte, in Lincoln County, a large acreage of beets has been grown for several years for the factories at Leavitt and Grand Island. It is quite probable that the factory at Leavitt will be removed to this place, or a new factory built in the next year or two. In Lincoln and surrounding counties beets have been grown to the extent of 11,000 acres for the season. Conditions favorable to sugar beets are well established.

UTAH.

Probably the history of no factory in operation in the United States better exemplifies the natural course of development than that of the factory at Lehi, which is among the oldest and most successful in the United States. For two or three years this factory did not receive sufficient beets to enable it to run at its full capacity. Gradually its supply of beets reached the maximum. Finally it was compelled to put in a slicing station to handle the beets grown some miles distant from the main plant, thereby increasing the sugar output of the main factory. In a short time another slicing station, and more recently a third, became necessary. In addition to this, in order to take care

of the beet-growing territory it had developed, this sugar company built a new modern plant at Garland, about 90 miles north of its location, and this plant has a working capacity equal to that of the original plant with its auxiliaries. While it was accomplishing this work, this company has also been promoting beet production in a large area in counties to the south, particularly Sevier and Sanpete, and has under consideration the establishment of another factory in this area.

An account of the situation in Sevier County is taken from the Salt Lake City Tribune of August 25, 1907, as showing the feeling in the district toward the beet-sugar industry:

F. B. Gould, beet field superintendent for Sevier County, furnished the Richfield Reaper with some interesting data regarding the sugar-beet industry in that county. The total number of acres contracted for planting this year is 1,224, against 882 for last year. This is an increase of nearly 40 per cent. With a little canvassing and soliciting among the farmers, it is very likely that the acreage could have been almost, if not quite, doubled. No effort was made for acreage this year, as the factory at Lehi is now supplied to its capacity. No encouragement whatever was given to new growers, and only a few were admitted to contracts this year. The acreage is divided among the various districts as follows: Monroe, 536; Richfield, 140; Joseph, 128; Elsinore, 101; Austin, 100; Vermilion, 100; Central, 68; Annabella, 38; Glenwood, 18.

The total tonnage of beets of Sevier County last year was 13,133 tons. Deducting 37 from the number of acres contracted, leaving 845 acres actually cultivated, the average yield was a little better than 15½ tons per acre. The crop brought $59,100 to the farmers of Sevier County, or a trifle less than $70 an acre. If the crop this year does as well as it did last season (and there is no reason to be divined at present why it should not) the total tonnage should be about 19,000 tons, representing nearly $80,000.

In regard to the siloing which the contracts call for this year, Mr. Gould said that that covered only 10 per cent of the crop. Twenty-five cents per ton additional is allowed for this work. Mr. Gould is of the opinion that this additional price will about cover the cost of siloing, as it is a simple process requiring very little extra labor. The beets are simply piled in shallow trenches and covered with beet tops. This will enable the growers to get all their beets out of the ground before the frost comes.

SOUTH DAKOTA.

South Dakota has been thoroughly tested by the State experiment station in conjunction with Government investigation. There are many places well adapted to the sugar industry, among which are Sioux Falls, Mitchell, Watertown, Brookings, Huron, and Aberdeen.

BELLE FOURCHE.—Recently, under the Reclamation Act, a large irrigation ditch was established at Belle Fourche. This place is located in Butte County, in the northwestern corner of the State. With reference to conditions and prospects for a sugar factory at this point, I submit a letter from R. F. Walter, Government engineer in charge; also a table showing the sugar contents of beets grown there:

BELLE FOURCHE, S. DAK., *February 28, 1908.*

DEAR SIR: The prospects for the building of a beet-sugar factory in this locality are excellent, and I have been informed by the capitalists that they are ready to build a factory here as soon as the water is ready to irrigate the land under the project. We will have about 12,000 acres under water this year, and probably 40,000 acres by another year, at which time they claim they will put in a factory.

We have had beets grown in small quantities here for two years by 20 or 30 farmers. Although they did not give the beets the care they should have, they secured fair results. I send you herewith a table showing the sugar contents of the beets grown during 1906.

The Belle Fourche project, when completed, will irrigate about 100,000 acres of very fine land. The soil is of two classes, about one-half being a sandy loam, the other half being a heavy clay soil. The clay soil seems to have given the best results so far with sugar beets. The project is about half completed at this time, the first section being irrigated this year for the first time.

Very truly, yours,

R. F. WALTER, *Engineer in Charge.*

Test of sugar beets dug October 20, 1906, in Belle Fourche Valley, South Dakota.

	Per cent of sugar.
J. M. Eaton	17.1
B. Kemper	14.7
Jno. McClure	16.1
J. W. Haines	16.8
A. T. Adams	14.5
U. S. Reclamation Service	16.6
R. H. Evans	12.7

WASHINGTON.

ELLENSBURG.—For the past two or three years Ellensburg, near the headwaters of the Columbia River, in Kittitas Valley, has been under investigation by capitalists and business men with a view to establishing the sugar industry. The beets have shown high quality and good yield.

In regard to this locality, I submit the following letter from C. W. Adams, connected with the North Pacific Sugar Company, a local organization designed to promote the sugar industry in this locality:

SEATTLE, WASH., *February 26, 1908.*

DEAR SIR: The prospects for the construction of a beet-sugar factory at Ellensburg are favorable. For the years 1905–6, from 60 to 80 plats of one-eighth of an acre to an acre of sugar beets were planted, experimentally, in all sections of the Kittitas Valley. The quantity of beets per acre ranged from 10 to 20 tons, the sugar content from 12 to 20 per cent, and the purity from 81 to 92.

There is about 55,000 acres of tillable soil in the Kittitas Valley. The nature of the soil is loam. It is all irrigated or subirrigated. The elevation is about 1,200 feet, and the climate is perfect for the growth of all tubers. In all respects the locality is favorable for the beet-sugar industry.

Yours, truly,

G. W. ADAMS.

OTHER PLACES.—Capitalists of Seattle and eastern points, in connection with local business men of North Yakima, have investigated beet-sugar production on the Columbia River. There is no place in the United States better adapted to the purpose. Some time in the near future a factory will be established at this place. Another large factory is being planned for the vicinity of Spokane.

WYOMING.

Wyoming has many valleys subject to irrigation, well adapted in quality of soil and natural conditions to the sugar industry. It has the fuel, both coal and oil. Natural conditions favorable to the sugar industry are much like those of Colorado and Montana. It needs transportation and development of irrigation facilities. The State is in its infancy in the development of its great resources. There are several places in the State considering the installation of the beet-sugar industry, the principal ones being Sheridan and Byron in the northern part of the State, and Wheatland in Laramie County in the southeastern part of the State, on the Chugwater River.

BYRON.—Byron is in one of the most fertile valleys of the West. It is located on the Big Horn River. In regard to local conditions and prospects for a sugar factory at this point, I submit a report by Byron Sessions, who has given considerable time and investigation to the subject:

BYRON, WYO., *February 27, 1908.*

DEAR SIR: We think we have the best land for the production of the sugar beet, with our perpetual sunshine, that there is in the United States.

The Shoshone River is the only river in the mountains, and its highest water comes in the month of July. This stream receives its supply almost wholly from the Yellowstone National Park, which is thoroughly protected from the ravages of man and beast.

The raising of sugar beets in the Big Horn Basin is no longer an experiment. We have been testing the beets for the last five years. In the year 1907 we grew at Lovell 321 acres of beets that would run over 15 tons per acre. These beets were shipped to the Billings sugar factory and showed an average of 18 per cent sugar, some going better than 20 per cent, and all better than 80 in purity.

We have plenty of water, good soil, and practically 365 days of sunshine. Our spring weather is such that we can get all our beets planted in April, thus giving them a good long season. We have no storms in the fall, only long warm sunny days and cool nights, which are ideal for putting the sugar into the beets.

The following are results of beet culture at Lovell in 1907:

Some results of sugar-beet growing at Lovell, Wyo., in 1907.

Name.	Acres.	Tons per acre.
J. M. Grant	52	14
Tippets Bros	40	16
A. A. Durfee	14	17
J. A. May	8	17½
R. Robertson	11	15
Allen Tracy	3½	18

The people of Lovell and Cowley have now contracted for 1,500 acres of beets for the Billings sugar factory for the year 1908.

We have at present lands that are thoroughly under control that have been irrigated, amounting to 8,000 acres, along the line of the Burlington and Missouri River Railroad, none of these lands being more than 3 miles from this road; 14,000 acres more that the canal is built upon near Lovell, which is situated on the line of the Burlington and Missouri River Railroad; and 30,000 acres that are now ready to have water turned upon it this coming April, at or near Garland, this county. The spur of the Burlington and Missouri River Railroad runs directly through this tract of land. The above tract is covered by canal through the Reclamation Service, with all of the laterals reaching each and every subdivision.

There are also at least 30,000 acres situated on the Greybull River, all of which is in alfalfa, only waiting the advent of the Burlington and Missouri River Railroad to put a line through this beautiful valley, which to my mind is the most fertile valley in the State of Wyoming.

Then there is what is known as the Shoshone River Canal and Oregon Basin Reservoir Irrigation Company. The canal is nearing completion and runs parallel with the Shoshone and Greybull rivers, having in all 150,000 acres of No. 1 land. In all there is at least 500,000 acres of land in this basin that is specially adapted for the culture of the sugar beets, and we are inviting capital to join with us in making this the greatest sugar-producing county in the United States.

Yours, respectfully,

BYRON SESSIONS.

WORK OF THE BUREAU OF PLANT INDUSTRY.

B. T. GALLOWAY, CHIEF.

OBJECT OF THE WORK.

The work covered by sugar-beet investigations of this Bureau embraces a study of the diseases, the cultural methods, the use of fertilizers, the development of special strains of beets—including beets resistant to alkali, beets suitable for semiarid sections, beets of large size and high sugar content—and the development of modified seeds, such as single-germ seed balls, etc. The work also includes the growing of commercial beet seed, which embraces methods of siloing, studies of types, analyses of roots, and methods of planting and harvesting. Efforts are also being made to find new localities where seed may be grown commercially for sugar. This work may be summed up under three general heads, namely, methods of increasing the sugar per acre, the production of American-grown seed, and the extension of the sugar-beet territory.

INCREASING THE SUGAR PER ACRE.

Efforts are being made to increase the yield of sugar per acre by increasing the size and quality of the beet and by improving the stand, so that the optimum number of beets per acre may be produced, care being used to give each beet the proper space for its best development. The principal factors affecting size, quality, and stand of beets are cultural methods, fertilizers, diseases, and special strains of beets.

CULTURAL METHODS.

The chief cultural methods under investigation are preparation of seed bed, which includes subsoiling, deep and shallow plowing, fall and spring plowing, summer fallowing, rotation of crops, width of rows, and deep, shallow, and late cultivation. Subsoil plowing seems to be advantageous if the subsoil is extremely hard; otherwise no results follow this extra expenditure of labor so far as our cooperative tests have shown. Deep plowing is advantageous if too much raw soil is not thrown up. The increased depth of plowing must be attained gradually. In general, shallow cultivation gives better results than deep cultivation; and the indications so far are

that the beet crop is as a rule "laid by" too early—that is, cultivating later in the season than is usually done materially increases the yield. It seems to be a disadvantage to plant the rows more than 20 inches apart. The work covering these and other cultural methods will be continued until more definite information is obtained in different parts of the sugar-beet belt.

FERTILIZERS.

As heretofore, experiments with stable manure, green crops, commercial fertilizers, and chemicals have been carried on with results similar to those of previous years—namely, the best results are obtained by the use of green crops and stable manure when properly handled. Commercial fertilizers when properly applied under certain conditions give large returns for labor and cost of material. As we sometimes get no results from the use of commercial fertilizers with sugar beets, considerable work must still be done in order to determine when, how much, and under what conditions the material should be applied. Due regard must also be given to the climatic conditions and cultural methods used in connection with the fertilizers. Certain chemicals, such as nitrate of soda, when applied at the rate of from 300 to 500 pounds per acre in the early part of the growing season, seem to yield a distinct advantage by increasing the size of beets without materially affecting their quality. Sugar beets require strong, rich, highly cultivated, and well drained land for best results.

DISEASES.

The tendency of fungous and bacterial diseases of sugar beets is to retard the growth of the plants, to kill them, or to reduce their sugar-producing ability. Whatever the direct effect of the disease upon the plant may be, the yield of sugar per acre is reduced. The diseases most commonly affecting the beet are damping-off, leaf-spot, curly-top, root-rot, and crown-rot. Damping-off usually occurs when the plants are very small and frequently interferes with the stand. If this disease is very serious, replanting may sometimes be resorted to with advantage. Damping-off is usually caused by a fungus, which in turn depends for its activity upon weather conditions. Several fungi produce spots upon the leaves; the most widespread and destructive of these is *Cercospora beticola*, which produces the disease known as leaf-spot. The effect of leaf-infesting fungi may show itself in a retarded growth of the plants or in a low sugar content, or both. These diseases do not usually attack the plants until they are several weeks old and therefore well established, so that they are seldom killed outright by these fungi. The yield of sugar per acre is, however, greatly reduced. Bordeaux mixture will control the leaf diseases, but the cost and

labor of applying it are at present a serious problem which we are now trying to solve.

Our work to date on curly-top has just been published as Bulletin No. 122 of this Bureau. It should be stated in this connection, however, that this disease is a very important factor in reducing the yield of sugar per acre, both by retarding the growth of the beets and by injuring the stand. Beets affected with this disease are usually low in sugar and owing to their woodiness are sliced with difficulty. Root-rot and crown-rot are both fungous diseases produced by well-known fungi. The former spreads through the soil and thrives best in neutral or slightly acid soils, and hence may be controlled by a liberal use of air-slaked lime sown broadcast and worked into the soil. The latter spreads by means of spores and may be prevented to some extent by spraying.

SPECIAL STRAINS OF BEETS.

In this connection should be mentioned the selection and breeding experiments which have for their object either an increase in the yield of sugar per acre or a decrease in the cost of producing the present output. This work embraces the development of a strain of beets larger and richer in sugar than our present varieties; also strains adapted to dry-land conditions and to alkaline conditions. It also includes the development of single-germ beet seed. This last project, which is now being conducted at three of our Bureau stations and is progressing satisfactorily, has for its object a reduction in the cost of growing beets by making the hand thinning unnecessary. The production of larger and richer beets tends directly to increase the yield of sugar per acre, while the development of dry-land and alkali-resistant strains will increase the yield of sugar under special conditions by improving the stand. It is plain, therefore, that proper cultivation and the judicious use of fertilizers directly increase the yield of sugar per acre, and that the prevention or control of diseases indirectly increases the yield of sugar per acre. Likewise, special strains of beets tend toward the same results either by actually increasing the sugar per acre or by reducing the cost of the sugar produced.

COMMERCIAL BEET SEED.

The development of commercial sugar-beet seed in the United States under the immediate direction of Mr. J. E. W. Tracy of this Bureau has been conducted for several years at five widely separated stations, and steps are being taken to establish other seed-growing stations in different parts of the sugar-beet belt. Considerable seed has been produced from beets weighing from 1½ to 3 pounds and testing from 19 to 24 per cent sugar. Efforts are being made to fix the high sugar-producing characters of the beet and at the same time to increase the weight of the roots.

COMPARATIVE TESTS OF AMERICAN-GROWN AND FOREIGN SEED.

Comparative tests have been made for a number of years for the purpose of determining the relative value of American-grown seed as compared with imported seed used by the various sugar factories. While the results to date show an average sugar content of beets from American-grown seed two-tenths of 1 per cent less than the average sugar content of beets from imported seed, the yield of beets per acre from American-grown seed exceeds the average yield from imported seed used by factories by 2.18 tons, thus giving the American seed the advantage in the yield of sugar per acre. These tests were made on a commercial scale, that is, in fields grown for factory purposes, and are not based upon plat experiments. A complete report covering these tests is now in preparation.

SILOING THE SEED BEETS.

One of the important factors in beet-seed growing, whether it be done commercially or for experimental purposes, is successful siloing of the roots. Various experiments have been conducted for several years with a view to determining which method is most satisfactory. So far as our work has gone, the best results have been obtained by piling the roots in long, low ricks, embedding them in sand, and giving them just enough protection during the winter to keep them cool without freezing. As heretofore, a study is being made of the possible relation between methods of siloing and seed production. The loss due to the failure of the beets to keep during the winter has been one of the most discouraging features in connection with seed production in some localities. This loss can undoubtedly be almost entirely overcome by proper methods of siloing. Another serious loss arises from the failure of the beets to produce seed stalks. To what extent this condition depends upon methods of siloing has not been fully determined. It seems to depend more upon the condition of the beets when siloed than upon the particular method used in keeping the roots through the winter.

EXTENSION OF THE SUGAR-BEET AREA.

Efforts have been made to determine in a general way what new localities are suitable for sugar-beet growing. This work has been taken up partly because of the inquiries received from those who, having capital to invest, desire to establish sugar factories in suitable localities, and partly because of a desire on the part of the farmers to know whether or not their soil and climate are suitable for profitable sugar-beet production. During the past winter and spring beet seed has been distributed to over 400 farmers in 21 States where sugar beets are not now grown commercially. Our plan is to furnish seed

to a number of reliable farmers in a given community where conditions for success seem favorable and to supply each experimenter with directions for preparing the ground, planting the seed, and growing the beets. Later a blank form is sent for a report on the progress of the experiment, and in the fall a sample of the beets is taken, weighed, and analyzed for sugar and purity. If the first season's results are encouraging in a given locality, it is desirable to repeat the experiments for several years in succession, in order to determine the effect of the seasonal changes that occur from year to year upon the size and quality of the beets. The beets grown experimentally may be used for stock feed if the quantity is too small or the distance too great to permit shipping them to a sugar factory.

As a result of these tests several factories are now in prospect, and from year to year data in regard to the growing of sugar beets in other places will be gathered and recorded for future reference. In general, it may be said that the sugar beet as a plant will thrive in a range of climate much wider than that in which it can be grown profitably as a sugar-producing plant. In other words, the sugar beet grows luxuriantly in many places where the sugar content is too low for the plant to be profitably grown for sugar. It should be added that the establishment of a beet-sugar mill depends not only upon a sufficient supply of roots rich in sugar but also upon a reasonable assurance that the supply will be constant from year to year, and that sufficient coal, lime, and water are easily obtainable.

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Issued February 6, 1909.

U. S. DEPARTMENT OF AGRICULTURE.

Report No. 87.

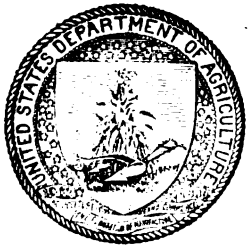
REPORT

OF THE

SECRETARY OF AGRICULTURE.

1908.

[ABRIDGED EDITION.]



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REPORT

OF THE

SECRETARY OF AGRICULTURE.

Mr. PRESIDENT:

I respectfully present my Twelfth Annual Report, covering the work of the Department of Agriculture for the year 1908.

The crops of the year and the other products of the farm first claim attention, after which the work of the Bureaus and other offices of the Department, in and outside of Washington, is summarized. Then follows a review of the progress of agriculture in this country during the last twelve years, with concise statements of the principal causes and the more prominent results.

AGRICULTURAL PRODUCTION IN 1908.

TOTAL VALUE.

Billions upon billions the farmer has again piled his wealth. Production has been above the average of recent years all along the line, with few exceptions, and some prices have been up while others were down. After offsetting losses against gains, in comparison with 1907, there remains a net gain which raises the total value of all farm products of 1908 to the most extraordinary amount in the world's history, $7,778,000,000.

INCREASE ABOVE FORMER YEARS.

The farm value of farm products this year is $290,000,000 above the value for 1907, $1,023,000,000 above that of 1906, $1,469,000,000 above that of 1905, $1,619,000,000 above that of 1904, $1,861,000,000 above that of 1903, and $3,061,000,000 above the census amount of 1899.

Expressed in the form of percentages of increase, the amount for 1908 was 4 per cent greater than that for 1907, 15 per cent over that for 1906, 23 per cent over that for 1905, 26 per cent over that for 1904, 31 per cent over that for 1903, and 65 per cent over that for the census year 1899.

A simple series of index numbers shows the progressive movement of wealth production by the farmer in another form. The value of products in 1899, the census year, being taken at 100, the value for 1903 stands at 125, for 1904 at 131, for 1905 at 134, for 1906 at 143, for 1907 at 159, and for 1908 at 165.

During the last ten years the wealth production on the farms of this country has exceeded the fabulous amount of $60,000,000,000.

CHIEF CROPS.

In the statement that follows concerning the crop quantities and values for 1908 no figures should be accepted as anticipating the final estimates of this Department to be made later. Only approximations can be adopted, such as could be made by any competent person outside of this Department.

CORN.

Greatest of all crops is Indian corn, the priceless gift of the Indian, who freely gave to the white man information which led to the production of 2,643,000,000 bushels this year. The crops of three years have exceeded this, but only the crop of one year—1906—exceeded it very much.

The value of this crop almost surpasses belief. It is $1,615,000,000. This wealth that has grown out of the soil in four months of rain and sunshine, and some drought, too, is enough to cancel the interest-bearing debt of the United States and to pay for the Panama Canal and 50 battle ships.

The price of corn is exceptionally high. There are only two years in the records of this Department in which the farm price of this crop was as high as it is for this year. In 1881 the price was 63.6 cents; in 1901, when there was only two-thirds of an ordinary crop, the price was 60.5 cents.

The total value of this crop is by far the highest ever reached. The crop of 1902 was worth a billion dollars, and the crops of 1904, 1905, and 1906 were worth $100,000,000 more; the great increase of $300,000,000 over the crop of 1902 was made in 1907, and now the increase is $600,000,000, equal to the gold in the treasury of a rich nation.

The corn crop far exceeds in value the prominent farm crops next below. It is worth nearly as much this year as the great crops of cotton, hay, and wheat combined.

In comparison with the averages of the preceding five years, the quantity of the corn crop of this year is 2.1 per cent higher and the value 42.6 per cent higher.

COTTON.

Commercial interests have agreed upon a large cotton crop for 1908–9, and, accepting their opinion for the moment, it seems likely that the crop stands with the highest three years in quantity. In value, however, it is apparently next to the highest, and perhaps equal to that, although the farm price of cotton this year is below the price of last year by more than 1 cent.

The average cotton crop of the preceding five years is considerably exceeded by the crop of this year, yet the value this year is hardly above the five-year average.

For the first time in the history of this country's agriculture the value of the cotton crop, including the seed, has apparently exceeded the value of the hay crop, which has heretofore held second place for a long series of years.

HAY.

The reason the value of the hay crop has lost its relative place in the scale of crop values is that the price is low because of high

production. The price this year at the farm is more than $2 per ton less than it was a year ago; so that, although the number of tons harvested this year was 68,000,000, or 11.7 per cent above the average of the preceding five years, the total value is but $621,000,000, or only 5.7 per cent above the five-year average. Otherwise compared, the hay crop is the largest ever produced in this country, and its total value has been exceeded but once.

WHEAT.

Wheat is 1.5 per cent above the five-year average in production and 23.3 per cent above that average in total value. The story would have been somewhat different had this country depended upon spring wheat alone, since that crop suffered considerably because of the drought.

In quantity the wheat crop is 660,000,000 bushels, and has been often exceeded, while the value is $620,000,000, and was never equaled, nor approached nearer than $66,000,000.

OATS.

The fifth crop in value is oats, with a total of $321,000,000, or 9.6 per cent above the five-year average. The quantity, however, was 9.3 per cent below the five-year average, and was represented by 789,000,000 bushels, the low amount being due to protracted drought. In only one year, 1907, has the total value of the oat crop exceeded the value this year, but the quantity has often been exceeded.

BARLEY.

The cereal crop next below oats in value is barley, with a production of 167,000,000 bushels, worth $86,000,000 at the farm. The number of bushels and their value have been exceeded only once, but in a comparison with the averages of the preceding five years the production is higher by 13 per cent and the total value by 22.6 per cent.

RYE.

Rye is a crop that has remained steady at a production of about 30,000,000 bushels or a little more in recent years, and the crop of this year is higher in comparison with the five-year average by only 3 per cent, although the total value is higher by 17 per cent. This value is about $22,000,000, which has been exceeded three times.

RICE.

The large rice crop of this year, 23,000,000 bushels, gives it a value close to that of the rye crop, or about $18,000,000. This is 28.7 per cent above the average of the preceding five years in quantity and 22.7 per cent above it in value.

No year has produced such a rice crop as this one in quantity, nor has the rice crop of any former year been worth as much to the producer.

ALL CEREALS.

When buckwheat is added to the cereals above mentioned, interesting totals are provided. While all of these cereals are measured by the bushel, they are not fully comparable one with another on this

basis; but, after all, in the grand aggregate of bushels of cereals there is some indication of comparative production, one year with another. The total quantities of cereals produced in this country this year is 4,329,000,000 bushels, an amount that has been exceeded three times.

The value of all cereals reaches the grand total of $2,694,000,000, an amount that is more than $300,000,000 above that of last year, and still greater than in former years.

In the five-year comparison, the number of bushels of cereals this year is higher by 0.2 per cent, and the value is higher by 32 per cent.

POTATOES.

On account of the unfavorable weather, the potato crop of this year is low in quantity, 275,000,000 bushels, being 5.1 per cent below the five-year average and having often been exceeded by crops of former years. In value, however, $190,000,000, this crop is 18.1 per cent above the five-year average and was never equaled in any other year.

SUGAR BEETS AND CANE.

In the production of sugar beets for sugar making, this year stands at the top, both in quantity and in its value to the farmer, although in both respects not much above the figures for 1906 and 1907; but, in comparison with the average of the preceding five years, the tonnage of this year is higher by 44.7 per cent and the value, $21,500,000, by 43.7 per cent.

The plantation value of sugar cane, molasses, and sirup for 1908 is estimated to be about $34,000,000, a value which was exceeded only in 1904, but in comparison with the five-year average the value is greater this year by 9.7 per cent.

The foregoing figures relate to raw materials of sugar, but it is always interesting to notice the estimates of the values of the finished product, or refined sugar for beets and raw sugar for cane.

The beet-sugar production from the crop of 1908 reaches a higher figure than ever before, or about 500,000 short tons, worth at the factory, with the pulp, about $45,000,000; this value also is higher than for any preceding year.

In the case of the raw sugar of cane, the production of 1908 has a commercial estimate of about 407,000 short tons, a quantity perceptibly greater than the high figures of four or five former years. The value of this product has been exceeded in only one year, 1904.

The value of the sugar beet and of the sugar cane to the grower, with the addition of such molasses and sirup as are made on the farm and outside of factories, makes a total of about $56,000,000 for 1908.

On combining beet sugar with cane sugar, the total production of 1908 is estimated to be about 900,000 short tons, an amount much above the total of the highest former year; the factory value of the two kinds of sugar is supposed to be $75,000,000, and this holds the record place.

The grand total value of the refined sugar of beets, of the raw sugar of cane, of beet pulp, of molasses and sirup of cane and sorghum, and of maple sugar and sirup, resulting mostly from commercial estimates, is $94,000,000 for 1908.

TOBACCO.

Tobacco production has been low for several years on account of a depression in price, but the price rose considerably in 1907 and is perhaps still higher this year. Apparently the value of the tobacco crop to the farmer this year is at least $70,000,000, or about the value of 1907, and much higher than in preceding years.

While the crop is under the five-year average in quantity, its value is over 15 per cent higher.

HOPS.

The extremely low price of hops in 1907 caused a great reduction in the acreage of 1908, with the result that the commercial estimate of the crop is 39,000,000 pounds, the value of which is about $4,000,000, both amounts being exceeded in many former years.

In comparison with the preceding five years, the quantity of the hop crop is lower by 27.6 per cent and the value by 42.9 per cent.

ALL FARM CROPS.

For the first time, the value of all farm crops this year equals $5,000,000,000, and of this total the value of the corn crop is about one-third; wheat, hay, and cotton combined make more than one-third; and the smaller crops the remainder, or nearly one-third.

The crop production for the year is on the whole a high one. Never before was the hay crop so large in quantity, nor the rice crop, nor the sugar-beet crop, nor beet and cane sugar production. The production of barley has been exceeded in only one former year, and cotton has been exceeded by only two years at the most.

With regard to crop values, this year leads all former years in the case of corn, wheat, rice, all cereals, potatoes, sugar beets, beet sugar, beet and cane sugar combined, and possibly tobacco.

Next to the highest value, in comparison with former years, was reached by cotton, hay, barley, oats, sugar cane, and cane sugar.

In comparison with the preceding five years, crop production has been higher for every crop mentioned above except oats, flaxseed, potatoes, tobacco, and hops; values were higher than the average of the preceding five years for every crop except cotton seed and hops.

Notwithstanding two or three rather alarming periods of drought during the growing season, after all, the crop production of the year stands high, although not extraordinarily so, and the level of values is high.

ANIMAL PRODUCTS.

To the farmer who has averaged hardly 20 cents a pound for the butter that he has sold, between 3 and 4 cents a quart for his milk, and about 1½ cents for each egg, and even to the consumer who has paid prices much above these, it is a striking fact that the value of the farm products of the dairy cow are getting closer and closer to $800,000,000, and that the eggs and poultry produced on the farm are worth as much as the cotton crop, seed included, or the hay crop, or the wheat crop.

These advances in value are not due solely to increase in number of cows and of poultry, but considerably also to advances in price. The mean factory price of Elgin butter was 19.66 cents in 1899, 28.5 cents in 1907, and 27.16 cents in 1908. The mean farm price of eggs throughout the United States was 11.15 cents in 1899, 17.02 cents in 1904, and 18.3 cents in 1908. The wholesale milk prices at Chicago and New York, respectively, were 10.5 and 10.12 cents per gallon in 1899, 12.24 and 11.76 cents in 1905, 14.375 and 12.886 cents in 1907, and 15.16 and 16.62 cents in 1908.

The mean wholesale price of dressed poultry in New York was 11.15 cents per pound in 1899, 12.97 cents in 1903, 14.9 cents in 1907, and 13.56 cents in 1908.

The aggregate value of animals sold and slaughtered increases year by year because of increasing number and also because of a rising price level, although in the case of some classes of animals prices fall at times.

In the aggregate the value of animals sold and slaughtered and of animal products at the farm amounts to about three-eighths of the value of all farm products, estimated upon the census basis. This value is getting closer and closer to $3,000,000,000.

FOREIGN TRADE IN AGRICULTURAL PRODUCTS.

EXPORTS.

Never before in the foreign trade of this country have the exports of domestic agricultural products been as valuable as they were in the fiscal year ending June 30, 1907, but the amount was only $37,000,000 below that amount in 1908, when the value of these exports was $1,017,000,000, or greater than for any year except 1907.

The falling off in exports in 1908 was due mostly to cotton, which showed a decrease of $43,000,000, a loss which was partially offset by an increase of $31,000,000 in exports of grain and grain products.

By far the largest item or group of agricultural exports was cotton, with a value of $438,000,000; next, grain and grain products, $215,000,000; and, third, packing-house products, valued at $196,000,000.

IMPORTS.

The loss in imports of agricultural products in 1908, compared with 1907, was $87,000,000, or much more than the loss of exports, the principal item of decrease being packing-house products; on the other hand, there were increases, chief among which were fruits and vegetables.

The principal items of import in 1908 were silk, $65,000,000; wool, $24,000,000; packing-house products, such as hides, etc., $66,000,000; coffee, $68,000,000; various vegetable fibers, $50,000,000; fruits, $28,000,000; vegetable oils, $16,000,000; sugar and molasses, $81,000,000; tea, $16,000,000; and tobacco, $23,000,000.

The total imports of agricultural products in 1908 were valued at $540,000,000 in the countries from which they were exported, a decrease of $87,000,000 from the amount of 1907.

TRADE IN FOREST PRODUCTS.

A decrease of $2,600,000 was the result of the export trade of this country in forest products of domestic production in 1908 as com-

pared with 1907, due mostly to a decrease in value of exports of lumber and, in a less degree, of timber.

There was a diminution also in the value of imports of forest products in 1908 compared with 1907, the loss being $24,000,000, found almost entirely in india rubber. There was a gain of $2,000,000, however, in the value of pulp wood and of $1,000,000 in wood pulp.

COMPARISON OF CLASSES OF EXPORTS.

On account of the sudden expansion of exports of manufactured products during the fiscal year 1908 the fraction of the value representing agricultural products and commodities whose manufacture is sustained mainly by agricultural materials declined somewhat in comparison with recent years and is now 61.5 per cent, while the fraction for forest products and for commodities whose manufacture is mostly sustained by forest products as materials is 7.8, and the fraction for exports that are not agricultural, nor of forest origin, either fully or in principal degree, is 30.7.

Animals and animal products contributed 16 per cent to the value of the total exports of 1908; cotton and cotton products, 26.9 per cent; grain and grain products, 12.2 per cent; all other products chiefly sustained by agriculture, 6.4 per cent.

BALANCE OF TRADE.

The exports of domestic farm products in 1908 being worth $1,017,000,000, the exports of foreign products being over $10,000,000, and the imports of farm products being $540,000,000, a balance of international trade in favor of the farm products of this country results, with the enormous value of $488,000,000.

During the same period the balance of trade in products other than those of the farm was $178,000,000, or an amount that has not been equaled within the memory of man. The agricultural balance was exceptionally high and has been equaled only in 1901 and 1898. The magnificent figures of the farmers' contribution to the exports of this country and to the favorable balance of trade are maintained in spite of this country's immense growth in population and extraordinary immigration of nonagricultural peoples, and also in spite of the diminishing fraction of the population that is engaged in agriculture. No analysis could more strongly indicate the progressive efficiency of the farmer's labor and capital and the telling effects of the agricultural sciences.

FOREIGN TRADE OF MORE THAN HALF A CENTURY.

AGRICULTURAL EXPORTS AND IMPORTS.

A compilation of the foreign trade of the United States in agricultural and forest products has just been completed as far back as the fiscal year 1851, and for the first time the general results are here made public. Annual averages by five-year periods are used for better understanding.

In 1851–1855 the exported agricultural products of domestic origin were valued at $150,000,000, and in the five years just before the civil war at $229,000,000. After that war the amount steadily grew by five-year periods to the great value of $875,000,000 in 1901–1905 and afterwards to $1,054,000,000 in 1907, the highest year of all.

The exports of agricultural products of foreign origin increased from $8,000,000, the annual average for 1851–1855, to $12,000,000 in 1901–1905, an amount that was not equaled in subsequent years.

The value of the imports of agricultural products at the beginning of the period under review was $68,000,000, as the annual average for 1851–1855. The average was progressive to the last period, with the exception of two five-year periods, and for the five years 1901–1905 it averaged $455,000,000. The highest amount ever reached was $627,000,000 in 1907.

Upon striking a balance of trade the evidence of the most remarkable power of the farmers of this country to produce a national surplus is brought out forcibly. For the first period, 1851–1855, the annual average balance in agricultural products in favor of this country was $89,000,000; the civil war diminished this, but the rise afterwards was fairly steady but firm until the period of 1896–1900, when there was a quick increase in the balance to $387,000,000, after which the amount has been always more than $400,000,000, except in 1905, and in 1901 it was $571,000,000, the highest amount in history.

During the entire period until 1898 the farmer provided this country with a balance of trade in his own products which offset a part or all of the unfavorable balance in the international exchange of commodities other than agricultural. After struggling with the load for a quarter of a century, he was able to overcome the adverse balance in commodities other than his own in 1876, when he began to produce a favorable balance of trade in the total of all commodities, steadily, year after year, with the exceptions of 1888, 1889, and 1893.

The per capita values of the exports of agricultural products expressed in annual averages by five years show that they have more than doubled during the half century under review. The per capita value during the period 1851–1855 was $5.84, and this average grew with several irregularities to $10.88 for 1901–1905 and to $12.29 for 1907, the highest amount of record.

On the other hand, the per capita value of the imports of agricultural products increased from $2.67 for 1851–1855 to $6.25 for 1871–1875, an amount that was not equaled by any subsequent five-year average. The average for 1907 was $7.30, which was higher by $1.05 than the great annual average for 1871–1875.

FOREST PRODUCTS.

The value of the exported forest products of domestic origin has steadily increased during the fifty-eight years under review. Beginning with an annual average of $6,000,000 in 1851–1855, these exports steadily increased in value to $28,000,000 in 1891–1895, after which the rise was rapid to $59,000,000 in 1901–1905, and to $93,000,000 in 1907, which was nearly equaled in 1908.

The per capita average of these export values was 24 cents in 1851–1855 and $1.08 in 1907.

Imports also of forest products have enormously increased in value during the fifty-eight years. They were valued at $2,000,000 as the average for 1851–1855, at $72,000,000 for 1901–1905, at $122,000,000 for 1907, by far the highest amount, and the value for 1908, $98,000,000, was next high.

The per capita value of those imports was 8 cents for 1851–1855 and $1.43 for 1907.

Rosin has increased in quantity of exports from the beginning to the end of the fifty-eight-year period, the number of barrels exported annually in 1851–1855 being 525,000, the number in 1901–1905 being 2,530,000, and in 1908, 2,713,000.

The exports of spirits of turpentine increased in a much greater degree than the foregoing, or from 1,000,000 gallons in 1851–1855 to 18,000,000 gallons for the ten years 1896–1905, after which there was a reduction to 16,000,000 gallons, but the greatest exports for any year were nearly 20,000,000 gallons in 1908.

Wood pulp has declined steadily in exports, the average for 1896–1900 being 45,000,000 pounds. It was 35,000,000 pounds in 1901–1905, 29,000,000 pounds in 1906, 25,000,000 pounds in 1907, and 24,000,000 pounds in 1908.

Imports of various items of forest products gain interest in a review for as long a period of time as fifty-eight years. Imported wood pulp averaged 42,000 tons in 1891–1895, and the gain was steady to 213,000 tons in 1907, and to 238,000 tons in 1908.

The pounds of imported india rubber rose from 38,000,000, the average for 1891–1895, to 77,000,000 in 1907, which was not equaled in 1908.

Imported cabinet woods increased steadily from an average of $515,000 in 1851–1855, to $5,000,000 in 1907, and the imports of timber and lumber other than cabinet woods were multiplied six times in value from 1856–1860 to the present time.

The farmer had many reasons for his Thanksgiving in 1908, as he had in recent former years. He has reaped as well as sowed. He has obtained more of the means with which to improve his farm, to increase his capital, to become a more generous consumer of the goods of other producers, and to add to the things that count for a better living and a more pleasant life.

THE DEPARTMENT'S WORK IN 1908.

LEGAL OPERATIONS.

Owing to the Department's duties in the enforcement of the food and drugs act, the new meat-inspection law, and the amended twenty-eight-hour law, together with the increasing scope and complexity of the Department's operations, the Office of the Solicitor has within the last two years assumed greatly increased importance.

ENFORCEMENT OF THE TWENTY-EIGHT-HOUR LAW.

During the year a very large number of cases have been brought, at the instigation of this Department, against various railway companies for violations of the twenty-eight-hour law, which limits the number of hours during which a shipment of live stock may be kept in cars without unloading. In 401 of these cases penalties were imposed amounting in all to $61,530, and costs were assessed amounting to $7,201.70, and 828 cases were pending at the close of the year.

OFFENSES AGAINST QUARANTINE LAWS.

For the failure to properly placard cars containing shipments of southern cattle from below the quarantine line, 33 cases were reported to the Attorney-General, and favorable decisions in 25 of these

cases resulted in penalties aggregating $2,400 and costs amounting to $123.83. Fines of $100 and costs were imposed in each of 4 cases against individuals for illegally removing southern cattle out of the quarantine area. For infractions of the law for the suppression of contagious diseases of animals, 8 cases were reported to the Attorney-General, the offense in each case consisting in the illegal shipment of sheep infected with scabies.

ENFORCEMENT OF FOOD AND DRUGS ACT.

At the beginning of the year no case had been brought for violation of the food and drugs act of June 30, 1906, although the machinery for the enforcement of the act had been created. During the year, however, 135 cases were reported to the Attorney-General, 97 of these being for criminal prosecution and 38 for seizure and condemnation. Of the criminal cases, 14 have resulted in convictions, the fines ranging from $5 to $700 with costs. Of the 38 seizure and condemnation cases, 14 resulted in forfeiture and condemnation. So far not a single case has been decided adversely to the Government.

The Solicitor has devoted much time and attention to the work of the Board of Food and Drug Inspection, of which he is a member. The consideration of questions submitted to the board for determination and the preparation of "Food Inspection Decisions" for the instruction and guidance of those who desire to conduct their business in strict conformity with this law have occupied much time and have been of far-reaching importance in securing compliance with the provisions of this act.

OFFICERS AND EMPLOYEES.

On July 1, 1908, as shown by the report of the Appointment Clerk, there were on the rolls of the Department 10,420 persons, 2,488 employed in Washington and 7,932 outside of Washington. The net increase in the Department force during the year was 1,313. The total number of appointments was 17,819. Of these 15,991 were to temporary or emergency positions, chiefly in the grade of laborer, continuing in most cases not more than three months and in many cases not more than one month, the great majority to positions outside of Washington. Resignations numbered 574, deaths 41, removals for misconduct 41, and separations from the unclassified service 31, while 128 persons declined to accept appointments. By far the largest increase, 741, is in the Forest Service. Positions on the statutory roll (those prescribed by the appropriation act) number 1,161, while 9,259 are on the lump-sum roll. More than 2,600 members of the Department may properly be classed as scientists. Contingencies arising in the Department's field work—demonstration farming, meat inspection, food inspection, protection of the National Forests from trespass and from fire, cattle-tick eradication, moth eradication, and insect fighting—account largely for the temporary appointments.

NEW BUILDING OPERATIONS.

The new Department building was completed during the year. While the contract date for the completion of the general construction work was November 29, 1907, the work was not finished until

four months after that date. On March 17, 1908, the building was accepted subject to the completion of several minor items of unfinished work, and steps were immediately taken toward its occupancy by the various Bureaus of the Department, which were very inadequately housed in scattered buildings rented by the Department. All of the general construction and mechanical equipment work has been satisfactorily completed, and final payments have been made thereon.

WEATHER BUREAU.

FORECASTS AND WARNINGS.

A few years ago the Department undertook to establish a research station at Mount Weather, Va., for the investigation of the problems of the air. This institution was planned to meet the highest requirements of science, and at the same time had as an object the acquirement of additional knowledge bearing directly on the forecasting of the weather. Heretofore the forecasts made by the Weather Bureau have been based entirely on the conditions of the air as observed at the surface of the earth, but for several years the Mount Weather station has been sending meteorological instruments into the upper levels of the atmosphere to find out what is going on there, and to obtain, if possible, additional information for the use of the weather forecasters at Washington in making their predictions. This object is now being realized, and the securing of data every day at altitudes of from 1 to more than 4 miles marks an important epoch in the work of the Weather Bureau.

Another important departure, made possible by continued study of the science underlying the art of weather forecasting, is the making of long-range weather predictions. These were begun for practice purposes, but not for publication, about one year ago. Their accuracy became so marked that within the past few months these predictions have been given to the public. We do not wish to hold out too alluring a prospect with regard to forecasts of this character, for at times the condition of the atmosphere may be such that long-range predictions can not be made, but we have demonstrated that in the majority of cases we can foretell a week in advance, and with a high degree of accuracy, the general character of the weather that is to come.

This gratifying result has been attained not only by getting observations from the higher levels of the atmosphere, but more especially by the securing of daily telegraphic reports covering the entire northern hemisphere, these being used in the preparation of a meteorological chart of such detail and extent as is attempted by no other weather service in the world. The value of these forecasts to the agricultural and other industries of the Nation can hardly be measured.

All severe storms on the American coasts and lakes and all severe cold waves and frosts in any portion of the United States during the year were successfully forecast.

RIVER AND FLOOD SERVICE.

With each succeeding year the development of agricultural operations and the extension of business interests more or less dependent

upon river stages necessitate some broadening of the field of activity of the River and Flood Service, and during the present year new work has been undertaken as follows:

(1) The establishment of a continuous flood-warning service, operating day and night in times of flood, in that portion of the State of West Virginia bordering on the Ohio River.

(2) The establishment of a new river district center at Binghamton, N. Y., with territory comprising that portion of the watershed of the Susquehanna River at and above Binghamton. This territory was formerly a portion of the Harrisburg, Pa., district.

(3) The opening of new river stations in the watershed of the upper Cumberland River, in the interest of navigation and the lumber industries.

(4) The opening of several new stations at scattered places throughout the country, in order to secure increased efficiency in the flood-warning service.

METEOROLOGICAL RECORDS.

A new series of climatological papers is being prepared, in which the records of precipitation, temperature, dates of the first and last killing frosts, and prevailing wind directions are collected, the precipitation tables including all available data since the year 1871. These reviews are made comprehensive for small sections of the United States, which it is intended gradually to cover in this manner. The papers will be of value to agriculturists, engineers requiring data on water resources, and other citizens who seek information regarding the climate of the several sections.

WATER RESOURCES.

A demand for a better knowledge of the water resources of the United States has become so urgent as to make it advisable to put forth special efforts to supply the necessary data to the public. In the arid and semiarid regions of the West these consist primarily in securing the amount of precipitation from rain and snow in the high levels of the mountains, from which are derived the waters that are used in the storage basins and the irrigation projects now undergoing rapid development. It is a difficult problem to secure regular and accurate observations of the amount of snowfall in the remote regions of the mountains, where there are very few inhabitants, but a special effort will be made by the Weather Bureau to extend the range of observations into the high levels of the mountains.

EVAPORATION STUDY.

In addition to measuring the water resources of the mountains, it is necessary to determine the amount of evaporation in the lower levels, where the storage basins are located. The amount of evaporation in the driest portions of the country, as in the Colorado Desert, may be as much as 8 feet of water annually, although it differs greatly according to circumstances. The importance of securing much more reliable information on this subject has made it desirable to renew the attack upon the problem. The formation of the Salton Sea in the Colorado Desert, by the overflow of the Colorado River during

the year 1906, affords a favorable laboratory on a large scale at which to make the proposed research on evaporation. A preliminary study on this subject was conducted by Professor Bigelow in the summer of 1907 at Reno, Nev., for the purpose of securing sufficiently adequate knowledge of the phenomenon to permit a proper planning of the campaign at the Salton Sea. The necessary plant was installed at the Salton Sea during the summer of 1908, and it is hoped that by continuing the observations for two or three years a satisfactory law covering evaporation generally may be secured. The problem is one of unusual difficulty from several points of view, but its practical value is such as to justify a serious effort to resolve it. The plan of cooperation with other Departments of the Government has been enlarged to include the Reclamation Service and the water resources branch of the Geological Survey, which are specially interested in evaporation at the reservoirs not only of the arid portions of the West, but in the eastern districts of the country. During the summer of 1908 several plants for the measurement of evaporation were installed at the reservoirs of the Reclamation Service and if practicable some other reservoirs in the central and eastern districts will be included. It is important to measure the evaporation in different climates on a uniform plan in order that a comprehensive law may be deduced.

BUREAU OF ANIMAL INDUSTRY.

ANOTHER OUTBREAK OF FOOT-AND-MOUTH DISEASE.

For the first time in six years the country has been visited with an outbreak of contagious foot-and-mouth disease, and the Department is now engaged in a vigorous campaign of eradication. The first news of the disease was received by telegraph November 10 from Dr. Leonard Pearson, State veterinarian of Pennsylvania, who reported that it existed in the vicinity of Danville and Watsontown, Pa. On the same day Dr. A. D. Melvin, Chief of the Bureau of Animal Industry, accompanied by Dr. John R. Mohler, chief of the Pathological Division, and Dr. R. P. Steddom, chief of the Inspection Division of that Bureau, left for Danville, and they soon confirmed Doctor Pearson's diagnosis.

A quarantine was immediately declared under date of November 12, effective November 13, against the interstate movement of cattle, sheep, swine, and goats from the counties of Columbia, Montour, Northumberland, and Union, and measures were at once taken in cooperation with the State authorities for stamping out the disease by slaughtering and burying the affected and exposed animals and disinfecting the premises which they had occupied. An arrangement was made by which two-thirds of the appraised value of the animals was to be paid by this Department and one-third by the State of Pennsylvania, other expenses to be shared on the same basis.

Within a few days the disease was also found in several other counties in Pennsylvania and in the vicinity of Akron, N. Y., and on November 19 the quarantine was extended to include the entire territory of the States of New York and Pennsylvania. This quarantine prohibited the interstate or foreign movement of cattle, sheep, and other ruminants and swine from either of the States named. Shipments were permitted by rail through those States

provided the cars were sealed by the Bureau of Animal Industry before they entered the quarantined territory. Such shipments were allowed to be unloaded in transit only in pens designated by the Chief of the Bureau and which had been cleaned and disinfected. The shipment of dressed carcasses from the States named was permitted only when the hides and hoofs had been removed, and the shipment of hides, skins, hoofs, hay, straw, etc., was forbidden unless such material had been disinfected by the Bureau.

It was fortunate that the Bureau of Animal Industry had available as part of its regular force a large number of trained veterinarians, many of whom had had experience in the successful campaign against foot-and-mouth disease in New England in 1902–3. A sufficient number of these men were quickly ordered to the infected districts and the work of eradication was actively prosecuted. Not only was the work of slaughtering, burying, and disinfecting carried on, but experts were sent to investigate all rumors indicating the presence of the disease in various localities.

It appeared that the cattle causing the Pennsylvania outbreak came through the Buffalo stockyards, and from Buffalo suspicion pointed to Michigan. Inspectors were dispatched to the latter State, and on November 23 I went to Buffalo in company with the Chief of the Bureau of Animal Industry to give personal attention to the situation. Evidences of infection from Michigan became so strong that I immediately proceeded from Buffalo to Detroit. On arrival in the latter city on the night of November 24, positive reports were received from our inspectors that the disease existed in several herds in Wayne County, and I at once declared a quarantine on the State of Michigan, to take effect at 6 o'clock the following morning.

On November 27, the disease having been found in Carroll County, Md., just over the Pennsylvania border, a quarantine was placed on the State of Maryland. The operations in Michigan and Maryland are being conducted on the same cooperative basis with the State authorities as in the other States.

It now seems clear that the present outbreak had its origin near Detroit and that the infection in the other States came from that source.

While it will not be surprising if a few additional diseased herds are found in the localities where the contagion is known to exist, it is hoped that all centers of infection have at last been located and that there will be no further extension of the infected territory. After all known affected herds have been slaughtered and buried and the premises disinfected, it will be necessary to make a careful and thorough inspection from farm to farm in the infected region in order to detect any contagion that may possibly remain. With the combined efforts of the State and Federal authorities there is every reason to believe that the disease will be eradicated within a reasonable time.

The expense of this work will be heavy, and I shall have to ask Congress to make an appropriation sufficient to cover it. For the present the expenses are being paid from the regular appropriation for general expenses of the Bureau of Animal Industry, but this appropriation is not large enough to stand the drain which is being made upon it without seriously affecting the regular work of the Bureau during the remaining portion of the fiscal year.

The Secretary of Agriculture already has power under existing legislation to enforce measures to prevent the introduction of contagious diseases from abroad so far as they are likely to be brought in with imported animals or with hay, straw, forage, or similar material, or meats, hides, or other animal products, from infected countries. No authority is given, however, to prevent the introduction of destructive animal diseases by the importation of virus or cultures of organisms causing such diseases, and I recommend that Congress enact a law which will empower the Secretary of Agriculture to guard against this danger. Such a law should prohibit the importation, except with the permission of the Secretary of Agriculture, of any virus that may be infectious for domestic animals. With this authority the Department could supervise such importations in such a way as to prevent the introduction of contagion by careless and irresponsible persons, while not interfering with any proper scientific work by responsible persons.

THE MEAT INSPECTION.

This was the second year of operation under the new meat-inspection law, and the experience gained has been productive of improvement in the methods of carrying on the work, while the regulations issued have been based on the best scientific knowledge and judgment available. There were engaged in this branch of the service at the close of the fiscal year 2,203 persons, of whom 616 were veterinary graduates. This force exercised a strict supervision over the slaughtering and packing operations at 787 establishments in 211 cities and towns. Compared with the previous year this is a gain of 79 establishments and 25 cities and towns.

As an example of the rigor of the inspection it may be stated that inspection was withdrawn from 8 establishments during the year because of violations of the regulations.

During the past year 53,996,511 animals were inspected before slaughter. Of this number 34,980,571 were hogs, 9,778,189 were sheep, 7,198,224 were cattle, 1,993,461 were calves, and 46,066 were goats. The animals inspected at slaughter numbered 53,973,337, an increase of 6 per cent over the previous year. Of these, 175,126 carcasses and 704,666 parts were condemned, 108,519 carcasses were passed for lard and tallow, and 53,689,692 passed for food. Tuberculosis was the cause of condemnation of about three-fourths of the cattle carcasses and about two-thirds of the hog carcasses that were condemned, and the majority of the other condemned hogs were affected with hog cholera and swine plague.

During the year the Government inspectors passed on nearly six billion pounds of meat-food products processed under their supervision.

There were condemned on reinspection during the year 43,344,206 pounds of meat products which had become sour, tainted, putrid, unclean, or, in the case of fats, rancid, since inspection at slaughter.

There was an increase of 13.8 per cent in the quantity of meats and products certified for export as compared with the previous year. Certificates to the number of 122,295 were issued, covering 1,545,761,808 pounds.

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The Federal law has no power over products prepared and consumed within the limits of a State, and a large amount of the meat supply—almost one-half the entire slaughter of the country—comes within this class. The Department has found that the worst sanitary conditions exist at many abattoirs where such meats are produced. It is only natural that suspicious and diseased live stock, such as would fail to pass the Government inspection, find their way into these small establishments, to be thereafter sold and consumed within the State. The Department has, moreover, frequently found preservatives in meats prepared by local butchers. It is therefore very important that State and city health authorities should provide adequate protection to their people by inaugurating a system of abattoir inspection that will do away with the evils mentioned.

INSPECTION OF EXPORT ANIMALS.

The routine work of the Bureau of Animal Industry includes the inspection of animals for export and of the vessels carrying them. During the year 638 inspections were made of vessels in order to see that the fittings, equipment, ventilation, feed, water, attendants, etc., complied with the regulations.

Our very large trade in live cattle with Great Britain is well known. This, together with other foreign consignments, made a total of 448,163 animals inspected for export, and as some were inspected more than once there were 757,890 inspections made. Of the animals sent to Great Britain 381,684 were again inspected on arrival at British ports by Bureau inspectors stationed there, and the losses in transit were less than one-fourth of 1 per cent.

CONTROL OF CONTAGIOUS DISEASES OF ANIMALS.

Gratifying progress has been made in eradicating the southern cattle tick, which spreads the infection of Texas fever and constitutes a heavy burden to the section involved. Since the beginning of this work less than three years ago nearly 64,000 square miles of territory have been freed from this troublesome and costly pest. The work is being done in cooperation with the authorities of the States concerned. There is no question as to the ultimate success of this great undertaking provided the assistance of the States and of the cattle owners themselves is forthcoming. As a result of this work 40,798 square miles were released from quarantine during the fiscal year. This territory was located in California, North Carolina, Tennessee, Virginia, Arkansas, Oklahoma, and Texas. Besides these States active work was carried on in Alabama, Georgia, Louisiana, Mississippi, Missouri, and South Carolina. In connection with this work 2,271,436 cattle were inspected during the year.

Very effective work has been done toward eradicating the diseases known as "scabies of sheep and cattle." During the year there have been released from quarantine on account of sheep scab the States of Idaho and Wyoming, and since the close of the fiscal year an order has been issued releasing Kansas and Nebraska and portions of North Dakota and South Dakota. There were released from the quarantine for scabies in cattle 4 counties in Kansas, 57 counties in Nebraska, and portions of North Dakota and Colorado. The number of inspections of sheep was 59,471,141, and the dippings 17,589,578. Of cattle there were 16,920,100 inspections and 1,527,280 dippings.

The question of tuberculosis in animals, especially in dairy cattle, whereby human beings are liable to be infected through the products, has for some time been an acute one. Statistics show that the disease is on the increase, and it is therefore imperative that efforts be made to cope with this great evil. A conservative estimate was recently made by the Chief of the Bureau of Animal Industry, based on the meat inspection and the records of the tuberculin test, which shows the percentages of our animals affected as follows: Beef cattle, 1 per cent; hogs, 2 per cent; dairy cattle, 10 per cent. The financial loss to our stockmen and dairymen was estimated to be fully $14,000,000 per annum.

In order to discover the disease, the tuberculin test should be systematically applied. The safest way of disposing of affected animals is to kill them, but in order to reduce the financial loss they should be slaughtered at abattoirs having Federal or other competent veterinary inspection. By this means many of the slightly affected carcasses could be safely utilized for food and thus made to yield their meat value.

Perhaps the greatest obstacle to the eradication of tuberculosis from our herds is the expense of the work and the payment of compensation to owners for the slaughter of their diseased animals. In such work that is largely for the public good it seems only just that the Government and the States should provide indemnity for at least a part of the loss. The benefits of eradication would unquestionably justify the expense, and when our herds have once been freed from tuberculosis it should be comparatively easy to keep them in that condition.

At last the problem of discovering a successful method of preventing hog cholera seems to have been solved by the Bureau of Animal Industry. The vaccine or serum prepared according to the methods of Dr. M. Dorset, chief of the Biochemic Division of that Bureau, has been further tested in a practical way during the year, not only by the Department, but by some of the State experiment stations, and its efficiency as a preventive measure has been amply demonstrated. The Bureau has carried on field tests during the year on 50 different farms and has treated approximately 2,000 hogs, with the following results: In herds which had not been exposed prior to treatment, but in which hog cholera appeared subsequent to treatment, all of the vaccinated hogs remained well, while more than 64 per cent of the unvaccinated hogs, which were otherwise kept under the same conditions as "checks," died. In the herds which had been exposed before treatment but which were apparently well when vaccinated, only 4½ per cent of the treated hogs died, while approximately 90 per cent of the checks were lost. In the herds where the disease existed at the time of treatment only 13 per cent of the treated animals were lost, while 74 per cent of the checks died.

In a series of careful tests carried on by Dr. J. W. Connaway at the Missouri experiment station with serum prepared by the Department method the efficacy of the treatment was confirmed, and in a report of this work he said: "The results of these tests are so satisfactory as to leave in every mind no doubt as to the great practical value of this method of preventing hog cholera."

Thirty-seven herds were treated in Michigan under the direction of the State experiment station, and in nearly every case the disease had

developed before treatment was begun. Out of 1,819 hogs treated, only 226 were lost.

The director of the North Dakota experiment station reports that when the disease recently appeared in the station herd the Department method of treatment was promptly applied, with the result that not a single animal died. As a further test the vaccinated animals were subsequently exposed to diseased hogs, but none contracted the disease.

The success which has attended the use of this treatment has been such as to warrant the use of the vaccine as an agent for combating the disease throughout the country. To prepare the vaccine on such a large scale, however, is beyond the power of this Department, and steps have been taken to interest the various States in the preparation of the serum. In accordance with this plan conferences of State veterinarians have been held at the Bureau experimental farm at Ames, Iowa, where opportunities have been given them to observe and learn the methods of producing and applying the serum. Already a number of State experiment stations are preparing and distributing the vaccine, some of them making a charge to cover the cost, and it is expected that other States will soon make the necessary provision for such work.

The presence of rabies, or hydrophobia, in dogs is still a menace to our people, and its disseminator, the rabid dog, is all too often allowed to roam at large and unmuzzled. The situation in the neighborhood of the National capital last spring became so alarming that the Commissioners of the District of Columbia were prevailed upon to issue a dog-muzzling order. While the prevalence of the disease has been diminished to some extent, the muzzling order has not been well enforced, and cases of rabies continue to occur.

The pathological laboratory of the Bureau of Animal Industry has continued to examine all animals sent there suspected of having rabies. During the fiscal year 117 such animals were examined and 82 of them were found to have been affected with the disease. The great majority of these came from Washington, D. C.

BLACKLEG VACCINE, TUBERCULIN, AND MALLEIN.

The Bureau has continued the preparation and distribution of vaccine to prevent blackleg in cattle. About 1,200,000 doses were distributed to stock raisers during the fiscal year, and reports indicate that the vaccine continues to be highly effective.

Tuberculin, for the diagnosis of tuberculosis, and mallein, for the diagnosis of glanders, are supplied to official veterinarians and health officers. During the year 213,015 doses of tuberculin and 52,556 doses of mallein were prepared and sent out.

LIVE STOCK IN PORTO RICO.

An investigation of the diseases and conditions of live stock in Porto Rico was undertaken during the past year. The majority of the island cattle carry an admixture of zebu blood as the result of the introduction of a number of zebu bulls in 1858. They are noted for superior size and working ability. Cattle all over the island are infested with ticks. The principal diseases are blackleg among cattle and glanders and epizootic lymphangitis among horses and ponies. There is no mange and no tuberculosis.

ANIMAL HUSBANDRY WORK.

The work in breeding American carriage horses, carried on in cooperation with the Colorado experiment station, continues with good results, and some very promising animals have been produced. During the fiscal year 4 Kentucky mares were added to the stud, which at the close of the year comprised 63 animals.

A stallion, two mares, and a filly were bought for the Vermont work in breeding Morgan horses, and the farm at Middlebury donated by Mr. Joseph Battell has been improved. Horses used in this work were exhibited at two fairs in Vermont and attracted very favorable attention. The Morgan stud consisted of 25 animals at the close of the fiscal year.

An experiment is also in progress in Iowa, in cooperation with the Iowa experiment station, to evolve a breed of American draft horses. The animals in this stud at present are imported Clydesdales and Shires. The horses have done well since their arrival in the summer of 1907, but no foals were obtained during the fiscal year.

The cooperative poultry work at the Maine Agricultural Experiment Station, begun in 1904, has been continued and some of the results are being prepared for publication. Other experiments in feeding poultry by different methods are in progress at the Bureau experiment station, but have not progressed far enough to yield definite results.

WORK RELATING TO THE DAIRY INDUSTRY.

The educational work for the development of dairying in the South has been continued with excellent practical results. Some of the drawbacks to the southern dairy industry are the lack of a sufficient number of good cows, the lack of home-grown feed, and the lack of suitable buildings. Efforts are being made to assist the southern farmers along all these lines. In order to determine which cows are profitable and which unprofitable, the farmers are encouraged to keep records of their herds. As an example of what is being accomplished in this respect, it may be stated that twelve months' records of 719 cows in small herds located in various parts of the South show an average profit per cow of $32.61; the best cow showed a profit of $94.40, and the poorest cow a loss of $3.73. The average profit of the best 10 cows was $79.24, while the poorest 10 cows made an average loss of 1 cent. It often happens that what are regarded as the best cows show, when tested, much poorer results than others in the herd, and it is by keeping records and compiling such information as the foregoing that the farmer is enabled to eliminate the poorer animals and to bring up the average production of his herd to a profitable point.

The Bureau has also assisted the southern farmers by furnishing plans for and supervising the erection of 45 silos, 28 barns, and 5 dairy houses during the fiscal year, and a larger number of such buildings are projected for the coming year.

It is the purpose of the Department to carry on this educational work in the South in cooperation with the State authorities and institutions so far as possible, and to prevail upon the States to take up and continue the work so that the Department may, after getting it well started and showing its benefits, withdraw and devote its

attention to other fields. Several of the States have provided men and appropriations for such work, and as the good results become more apparent the interest is increased.

Considerable work has been done during the year for the improvement of milk supplies. This has usually been done by giving assistance to city boards of health and to dairy farmers. One hundred and forty cities have been given more or less assistance during the year and a number of these have made marked improvement in their milk supplies. The score card has proved to be an important agency in improving the sanitary condition of the dairies. By means of this card the specific features are rated on a definite scale, and it is much easier for the health authorities and the dairymen to determine just what conditions need improvement. Two hundred and six dairies with 8,527 cows were inspected and scored during the year, the average score being 51.05 on a scale of 100. Reports have been received on about 10,000 dairies that were rated by officials and persons outside of the Department, and the average score of these was 52.05. It appears that there is a greater need for improvement in methods than for better equipment.

The Bureau has also continued its work of inspecting butter as received at 3 of the principal markets and reporting its condition to the creamery, the purchaser, and the dairy and food department of the State where the creamery is located. By this means many of the creameries have been enabled to improve materially the quality of their product. It has been found, however, that much of the poor quality of butter is due to the fact that some of the cream is very old when received by the creamery and it is impossible to make good butter from such material. This condition is due partly to the competition between the local and the "centralizer" creameries and partly to the way the cream is handled on the farm.

In the enforcement of the law regarding the inspection of renovated butter the Bureau has exercised supervision over 46 factories and has inspected their product and the material entering into it. There was produced during the fiscal year 50,658,158 pounds of renovated butter, a decrease of 12,261,840 pounds.

BUREAU OF PLANT INDUSTRY.

During the past year the work of the Bureau of Plant Industry has been pushed forward vigorously. Its research work in the laboratory has resulted in a number of important discoveries, its experimental field work has developed new methods of applying fundamental principles for the benefit of agriculture, and its efforts in the line of practical demonstrations and cooperation with farmers, fruit growers, and others have brought the Department into close contact with the people.

SEEKING NEW CROPS FOR THE AMERICAN FARMER.

EXPLORATIONS IN CHINA, KOREA, AND SIBERIA.—In pursuance of a general policy, energetic efforts have been put forward by the Bureau the past year in the matter of securing new crops and establishing new agricultural industries. During the year more than 2,000 carefully selected, newly introduced plants have been brought in and placed in the hands of thousands of private experimenters and official

plant breeders, and others attached to State and other experiment stations of the country. We are still sending abroad many millions of dollars for products which may well be grown at home, and in carrying out the general plan of securing data bearing upon the production of these crops and the crops themselves, the explorations and other work outlined below were carried on. One of the agricultural explorers, Mr. Frank N. Meyer, who for the past three years has been in China and Siberia, returned to this country in July after a continuous search during that time for new crops. This is one of the most extensive pieces of agricultural exploration work which the Department has undertaken. In addition to the many hundreds of new plants which Mr. Meyer secured he has brought back a fund of information which will be valuable in connection with our various lines of work here. Mr. Meyer devoted considerable attention to the Chinese methods of growing crops under dry-land conditions, and the information he secured regarding dry-land farming practices, horticultural methods, market-gardening operations, and the vast forestry practices of the Chinese Empire reveals in a remarkable way the wonderful variety of plants grown by the Chinese and the great similarity of the climate of eastern Asia to that of the United States.

The explorations made by Mr. Meyer in certain of the Chinese provinces reveal the presence of an extensive orchard industry which is worthy of serious consideration for our dry southwestern regions, the Chinese regions and our southwestern country being very similar in climate and soil. Mr. Meyer found extensive orchards of what is known as the "Chinese date," a drought-resistant fruit tree of which the Chinese have developed hundreds of varieties and of which the dried fruits form a most palatable and valuable fruit product with which this country is entirely unfamiliar. He secured numerous varieties of this date, among which was a seedless sort which is now being propagated for distribution in the Southwest.

A large collection of wild and cultivated pears was secured; also varieties of wild walnuts and chestnuts. There were also secured wood for the propagation of the famous Feitcheng peach, specimens of which weigh over a pound, as well as new apricots and wild apples which it is believed will be of particular value to the breeders of the Mississippi Valley, who are developing hardy forms of these plants.

EXPLORATIONS IN CENTRAL ASIA.—Recognizing that the Great Plains region of this country is in much need of assistance, explorations were inaugurated the past year with a view to securing forage and other crops for this vast section of the country. Early in the summer Prof. N. E. Hansen, of the South Dakota experiment station, was sent out to make a thorough exploration and investigate the probable value for the United States of certain promising alfalfas, clovers, grasses, and other crops of southern, central, and western Siberia. In a letter dated October 24, from Omsk, Professor Hansen reported the finding of good seed of one of the three yellow-flowered Siberian alfalfas which he started out to secure. This is the same plant found by Professor Hansen in 1906, and he now states that it is a fine, erect-growing type, with large leaves and large, flat pods. Both the Mongolian and flat-pod alfalfas are now coming to America for the first time, and Professor Hansen deems them very promising, owing to their extreme hardiness and their strong, erect habit, which will make mowing easy.

Professor Hansen also reports the finding of the Siberian lupine clover, which extends to 70° north latitude, which is also a fine, erect plant well liked by stock; also two wild red clovers.

This work of Professor Hansen is carried on in a climate very similar to that of the northern Great Plains region, and it is hoped that the new introductions will add materially to the wealth of the northwestern farms and pastures.

EXPLORATIONS IN SWEDEN, DENMARK, AND GERMANY.—In order to ascertain why American barleys are considered by experts inferior to the best European-grown barley, Dr. Albert Mann, an expert of the Bureau, was sent as an explorer to Sweden, Denmark, England, Germany, and Austria to make a thorough study of the methods employed by our European neighbors in the improvement of one of their most important grain crops. Doctor Mann has secured data regarding the latest processes used by European workers in the breeding and selection of barley for special purposes, and in particular the Svalöf system of collecting and classifying new varieties of this and other grains, and he has been successful in perfecting methods for rapidly determining the value of barleys, methods which will be very useful in the continuation of the important work on the improvement of this crop now under way.

MATTING PLANTS FOR FLOOR MATTINGS.—As the result of previous explorations in the Orient and elsewhere, and as announced in previous reports, the Department has put itself in possession of a collection of matting plants of the best varieties, and the present season has seen the production of matting straw which has been pronounced by experts equal in quality to that grown in the Orient. The first piece of home-woven straw matting has been produced here from straw grown by the American farmer, and the experts are now at work devising cheaper methods of planting, harvesting, splitting, and curing these matting plants, large quantities of which we import every year.

EGYPTIAN COTTON IN THE SOUTHWEST.—The United States imports about $15,000,000 worth of Egyptian cotton annually for the manufacture of special fabrics. The growing, grading, and handling of this crop have been so perfected that the product is exceedingly uniform, and the fiber being of a very high quality, fancy prices are always received for it. For a number of years the Department has been endeavoring to establish this crop in the United States. Several years ago some work was undertaken in the Southwest, notably at Yuma, in cooperation with the Reclamation Service on one of their projects. This work has already progressed sufficiently to warrant us in saying that there is a great promise of establishing an important cotton industry in the region mentioned.

The past year a total of about 40 acres was planted to Egyptian cotton at various localities in southern Arizona, seed of the acclimatized strain that has been grown for six years in the Southwest being used. The indications point to an average yield of 1 to 1½ bales per acre wherever the planting was done in good season and the cotton received reasonable care. A good commercial fiber was obtained, satisfactory in strength and fineness but not in the matter of length and color. It is planned to sell the product at the highest price obtainable in order to ascertain approximately what profit can reasonably be expected by growers of Egyptian cotton in the Southwest.

The marked interest in these experiments evinced by a number of American manufacturers of Egyptian cotton makes it reasonable to expect that the Arizona-grown fiber can be marketed advantageously.

THE GROWING OF DUTCH BULBS IN AMERICA.—The United States imports bulbs each year to the value of $300,000 to $400,000. A number of efforts to grow these bulbs in the United States have been made. Certain sections of the State of Washington seem to be well fitted for this sort of work. It is planned to grow bulbs now used by the Department and bought abroad, and by this means aid in demonstrating the feasibility of growing the crop in sufficient quantity for commercial purposes.

EXTENSION OF THE CEREAL WORK.

DURUM WHEAT.—The total production of durum wheat for 1907 appears to have been somewhere between 45,000,000 and 50,000,000 bushels, a little larger than that of the previous year. Of the total crop, over 25,000,000 bushels were exported. For 1908 the crop of durum wheat will probably be something over 50,000,000 bushels. There is already a large export of the 1908 crop, a considerable quantity having been shipped to Russia, from which country our own seed was originally obtained. It is evident that the demand will again exceed the supply before the winter is over.

In connection with durum wheat, the operations of the year have witnessed some new enterprises with respect to utilization of the crop. One of the largest milling firms in the country has used one mill entirely for grinding durum flour, while a very large milling concern in another city has launched into an extensive production of durum wheat semolina for macaroni manufacture. Extensive tests have also been made during the year by prominent bakers in this country and Europe in the use of durum wheat flour for bread, all of which have been fairly successful. Scotch bakers are now importing the wheat for bread making.

EXTENSION OF THE WINTER-GRAIN AREA.—With a view of extending the area of winter-grain production in the Northern and Western States the Kharkof strain of the Crimean or Turkey hard winter wheat group has been still more widely grown during the past year, not only in Kansas and Nebraska but in Colorado, Wyoming, South Dakota, Iowa, and portions of North Dakota, Minnesota, and Wisconsin. In all trials of the various winter wheats on State experimental farms in Wisconsin the Kharkof did much better than other varieties, which included two or three other hardy strains from Russia. An important conclusion derived from several years' experiments with this wheat is that it is particularly hardy in cold districts which are also dry—that is, it is rather remarkable in its resistance to a combination of drought and cold.

CEREALS FOR DRY FARMING.—More attention than formerly is being given to the development of drought-resistant cereals. During the year work has been started at six different stations located in representative sections of the Great Plains and intermountain areas. Large numbers of varieties of grain are being tested at these stations for their hardiness and drought resistance. While only one year's results have been secured, many new varieties introduced have outyielded ordinary sorts from 20 to 50 per cent.

EXTENSION OF THE RICE WORK.—Important work has been carried on during the year in cooperation with the Louisiana experiment station at Crowley, La. A study has been made on this farm of the manner and time of opening of the rice flower, which will be of much value in aiding all future work in the cross-breeding of rice. A classification of the known varieties of rice has also been prepared, which will be of use in future investigations. Efforts are being made to extend the rice work through the adoption of better varieties, improved methods of growing crops, and the extension of the area into other regions, notably California and Arkansas.

PROGRESS OF FORAGE-CROP WORK.

During the year the important work of encouraging the production of forage crops throughout the country has been vigorously prosecuted. This work has for its primary object the encouragement of the production of forage crops of various kinds wherever it is possible to do so in connection with other systems of farming. A special effort has been put forward to push the production of leguminous forage crops in the South, to extend the field for alfalfa culture in the Middle West and East, and to secure and establish forage crops of various kinds, particularly legumes, for the colder Northwest and the dry sections of the Middle West and Southwest.

ALFALFA EXTENSION.—During the past three years an extensive series of cooperative experiments in growing alfalfa has been conducted with farmers in the States of Maryland, Delaware, Virginia, and North Carolina with a view to determining the possibilities of this crop. These cooperative experiments number over four hundred and have been undertaken in many instances with the help of State experiment stations. They have been made primarily to determine the governing factors in the growing of this important crop in the various sections. Some of these factors are now well established, and it is believed that the work done will be of great value in getting this important crop more extensively used throughout the region in question.

WINTER LEGUMES FOR THE COTTON BELT.—Much attention has been given during the past year toward encouraging the greater use of winter legumes. Experiments throughout the South have indicated satisfactory results. Numerous demonstration experiments have been undertaken with farmers in most of the Southern States. In the very numerous instances where failure with these legumes has heretofore been reported the difficulty is found to be due largely to lack of inoculation. Whatever be the factors involved the fact is clear that inoculation is very difficult to obtain in the South except when using soil from an old field of the particular legume planted. The results of the work thus far indicate that crimson clover is to be preferred on the sandy lands, while vetch does best on the heavier soils. Experiments further indicate that when once the land is thoroughly inoculated there is little difficulty in securing satisfactory stands both of vetch and crimson clover when sown in the cotton in late summer.

A NEW LEGUME FOR THE SOUTH.—In 1906 there was obtained from the Philippine Islands a new bean, *Mucuna lyoni*, related to the Florida velvet bean. Although this has been grown but two years, in

comparison with the Florida velvet bean it is already demonstrated that it is much more prolific and somewhat earlier, at the same time being just as vigorous a grower. So markedly has its superiority shown itself as regards heavy seed production that many cooperators have not hesitated to predict that it will within a short time entirely supplant the Florida velvet bean. It is not unlikely that this variety will succeed farther north than does the Florida velvet bean, and it is certain that it will ripen its seed considerably farther north than that variety.

TOBACCO INVESTIGATIONS AND EXPERIMENTS.

The tobacco work as outlined in previous reports has been continued during the year. This work has been carried on in the Connecticut Valley, Florida, Texas, Alabama, Kentucky, Tennessee, Ohio, New York, Maryland, and Virginia, the object being to secure improved types by methods of breeding and selection, and to fix these types and establish them, to demonstrate the best means of growing the crops in the various regions, to accomplish the wide distribution of seeds of improved types, to introduce rotation and diversification, to aid in maintaining the fertility of the land where tobacco is made a specialty, to study various diseases, and by work in the laboratory to solve important points concerning the questions of burn, aroma, etc. The work in the Connecticut Valley has placed the industry on a new basis, it having been conclusively demonstrated that the varieties originated are eminently adapted for culture under shade and in the open field. The culture of tobacco under shade in the Connecticut Valley has been put on a profitable basis by the growers through the use of the Hazlewood Cuban tobacco, an extremely uniform variety adapted for culture under shade in this valley, and the use of improved methods of culture, the result of experiments and experience.

Important work has been continued in the matter of securing cover crops for the tobacco fields during the winter. Several years ago hairy vetch was introduced into this section, and it has been demonstrated that this crop adds about $18 per acre of nitrogen to the soil, and its value, both as a fertilizer and for improving the humus condition and the physical condition of tobacco lands, is estimated to be worth at least $35 per acre.

In Florida fourteen tobacco breeding fields have been conducted with individual growers. These fields are located so as to secure variety in cultural conditions, soil, and other things. In Texas the work has been mainly in connection with pushing the work of growing wrappers and cigar fillers. Assistance has been furnished growers in the way of expert advice as to methods of culture, curing, and fermentation of the crop. About 75 acres of shaded tobacco and 250 acres of Cuban filler types have been grown in the State. In Alabama the work has been with cigar filler and wrapper tobacco. In Kentucky and Tennessee extensive breeding work and fertilizer tests have been continued with the various types grown there. Similar work has been carried on in Ohio and New York. In addition to the definite experimental work under way in the different tobacco sections the Department is cooperating with a large number of individual tobacco growers who have taken up the systematic improvement of established varieties of tobacco.

An extensive system of fertilizer experiments, which in some cases have now been going on for four years, has been conducted in a number of locations in the States named and on all varieties of soils, and indicate how readily soils known to produce about 800 pounds of tobacco to the acre can be improved so as to produce 1,400 to 1,600 pounds per acre and at a greatly increased net profit. At the same time the work has demonstrated the value of rotations and fertilizers in building up and maintaining the fertility of the land. Fine crops of 2½ to 5 tons of hay per acre have been grown in rotation with tobacco and other crops. This work is being done in cooperation with State experiment stations, all of which are contributing liberally in the matter of expenses involved.

WORK OF THE PLANT PATHOLOGISTS.

ORCHARD-FRUIT DISEASES.—Studies of orchard-fruit diseases have been continued along a number of lines. In California the Bureau has continued to give expert assistance to the California growers in combating pear blight. The California growers and the State and county horticultural commissioners and the State experiment station are cooperating with the Department in this work. Pear blight during the past year or two has invaded the fine pear orchards of the Rogue River Valley in Oregon, and the Bureau pathologists were called there to assist in the effort to stamp out the disease or control it. Important work has been carried on during the year in connection with the little-peach disease and peach yellows, the winter injuries of fruit trees, the gumming fungus of the peach and other stone fruits growing in California and other Pacific Coast States, and certain injuries to apple and peach foliage as a result of spraying with Bordeaux mixture and other fungicides.

DISEASES OF TRUCK CROPS.—The great development of the trucking industry along the Atlantic and Gulf coasts has brought with it a host of new problems for investigation. The growers rely almost entirely on commercial fertilizers for the production of their crops, and some have used them exclusively and in excessive amounts until distinct nutrition diseases have appeared and caused much loss. The Bureau is studying these malnutrition problems and has already shown that by a suitable modification of the fertilizer formulas, together with the use of lime, stable manures, and green manures, the diseases may be prevented. Potato spraying—an established practice in Northern States—has not come into use in the trucking sections. The Department is adapting methods and practices to local conditions, to the end that better control of all potato diseases may be had. Similar work is being done with cucumbers, cantaloupes, and other truck crops grown extensively along the Atlantic coast.

DISEASE-RESISTANT COTTONS.—The increase and further improvement of the wilt-resistant Upland cottons mentioned in previous reports continue to receive attention. The distribution of several hundred bushels of seed has resulted in the general introduction of these varieties into infected districts. We now have under way selections designed to be adapted for boll-weevil conditions. Special attention is called to the desirability of practicing crop rotations for the control of root-knot in the South and to supply something to take the place of the ordinary cowpeas, which must be avoided in such rotations, and wilt-resistant and root-knot-resistant varieties have been developed.

IMPROVEMENT OF CROPS BY BREEDING AND SELECTION.

WORK ON CORN IMPROVEMENT.—Gratifying results have been secured during the past year in the breeding of improved strains of corn. The breeding work has been conducted so as to cover a wide range of territory, extending from the most southern through the central and into the most northern States. As a result of the work the past three years a high-yielding strain of corn showing remarkable adaptability to dry-weather conditions has been developed in Texas. This strain has proved of value in Arizona and other parts of the Southwest.

The breeding of strains of corn for increased yield, greater uniformity, and adaptation to soil conditions in localities where grown has been continued at points in Tennessee, Virginia, Maryland, and Ohio. At all of these points the Department selections have shown their superiority to the strains commonly grown. In Virginia during the past year fields grown from one of these selections produced from 90 to 100 bushels per acre, which was about one and one-half times the average yield in the community where the crop was grown.

In Wisconsin the Department has developed a high-yielding early-maturing variety that produced last year during an unfavorable season 100 bushels to the acre.

Breeding experiments have been started the present year in California, Nevada, and Arizona to secure strains adapted to the peculiar conditions prevailing in those localities.

The work in the improvement of sweet corn has been continued, and several high-yielding strains of excellent quality have been developed as the result of work in New York, on the Arlington Experimental Farm in Virginia, and elsewhere.

FARMERS' COOPERATIVE BREEDING WORK.—With a view to bringing the results of the breeding investigations of the Department home to the farmer in such a way that he can adopt the practices which the Department has been perfecting, extensive cooperative work has been inaugurated in a number of Southern States. Cooperative breeding work with several types of cotton and corn was conducted with a number of farmers where the conditions were favorable for the development of new and improved varieties of these crops. Two distinct and new types of corn and six of cotton have produced such marked increase in yield per acre as to demonstrate their value for this work. These types have been adopted by the cooperators for extensive breeding work next season.

SUGAR-BEET INVESTIGATIONS.

Investigations regarding sugar-beet growing have been continued during the past year along the same lines as indicated in previous reports. Special efforts have been put forward in connection with the growing of pedigreed strains of sugar beets, this work having been carried on in several States. Further comparative tests with American-grown seed and the leading varieties of imported seed have been conducted on a commercial basis with encouraging results, the amount of sugar produced per acre being somewhat greater in the case of the American-grown seed than in any of the imported varieties. The field work in the use of commercial fertilizers in connection with the growing of sugar beets is still under way. Further

work is also being carried on in connection with effective cultural methods, the objects being to determine the most satisfactory depth of plowing, width of row, manner of cultivation, and other operations in connection with growing beets.

PURE-SEED INVESTIGATIONS.

The pure-seed work has been extended during the past year by the establishment of testing laboratories in cooperation with the Nebraska Agricultural Experiment Station and the Missouri Agricultural Experiment Station. At the laboratory in Washington, D. C., a larger number of samples of seed have been tested for farmers and seedsmen than in previous years. As directed by Congress, forage-plant seeds have been secured from dealers and examined for the presence of adulterants. Many lots of Kentucky bluegrass and orchard-grass seed have been found to be adulterated, but the practice of adulteration has practically ceased with other forage-plant seeds.

The efforts of this Department in encouraging the use of good seeds are being appreciated, and a reflection of this is seen in the fact that several of the larger seed houses have recently established private seed-testing laboratories. On account of the lack of instruction in technical seed testing in the agricultural colleges this Department has offered assistance along this line. So far a number of seedsmen, as well as State agricultural experiment station workers, have availed themselves of this opportunity.

DRUG AND POISONOUS PLANT INVESTIGATIONS.

WORK ON DRUG PLANTS.—This work has for its object the establishment of new industries in the line of growing certain crops as drugs. In a previous report attention was called to the success attained in establishing the camphor industry in Florida. Further work has been pursued in this field, seed beds having been constructed and a considerable quantity of seedlings started for transplanting to the field. Certain regions of the South have been found particularly adapted to the production of drug and similar crops.

Some important investigations in connection with hop growing have also been carried on during the year; also important work in the line of growing tannin crops. Closely allied with the tannin problem is that of vegetable dyes, which is receiving attention in this connection.

POISONOUS-PLANT INVESTIGATIONS.—During the past year the main emphasis has been laid on the loco-weed studies. Field studies have been continued having for their object the working out of methods of diminishing losses not requiring individual treatment. Thus far the results have not been promising. A laboratory study of the loco weed seems to show that barium is a constant constituent in loco plants which are capable of producing the disease. Feeding experiments have led to the conclusion that barium poisoning is one of the factors that has to be reckoned with in dealing with losses from loco weeds. A study of the distribution of barium in the soil and in the loco-weed flora of eastern Colorado has been begun in cooperation with the Bureau of Soils. At the request of the Forest Service special investigations were undertaken of poisonous plants growing in the Na-

tional Forests. Botanical studies of the flora of the regions suspected to contain poisonous plants have been inaugurated. Plants of unknown characteristics suspected of having toxic properties are forwarded to Washington for laboratory investigation.

CROP TECHNOLOGY.

A number of important lines of investigation recently inaugurated by the Department have, owing to their close relationships, been grouped under the general head of crop technology. Certain important biological studies of grains come within this category; also the new work authorized by Congress on cotton standardization and fiber investigations.

COTTON STANDARDIZATION.—The subject of cotton standardization has received careful attention ever since the agricultural committees of Congress first began to give the matter consideration. Good progress has been made toward establishing the nine official standards directed by Congress. The different American and foreign cotton exchanges have responded generously to an invitation to assist in this important matter. These numerous exchanges have contributed their standards free of cost, thus insuring an extensive collection as data for the establishment of official grades. The work undertaken in connection with this important project gives full consideration to all the problems involved in the raising, picking, ginning, baling, warehousing, grading, pressing, shipping, and spinning of cotton, and at a later date it is confidently expected that the official standards will be elaborated without alteration of their fundamental character, so as to be much more useful than any standards have ever been in the past. The possibility can now be clearly seen, through technical examination of the cotton fiber of this country, of so improving cotton classification that all interested in the cotton industry will be materially benefited. Careful studies have been made of the baling and handling of cotton, and a bulletin on the subject has been prepared. The present methods of baling and handling entail an annual loss of millions of dollars. The investigations along this line, together with the adoption of uniform grades, should result in great improvement.

PAPER MANUFACTURE.—With reference to the paper work, under special authority given by the last Congress a comprehensive series of tests is being undertaken in conjunction with the Forest Service and the Bureau of Chemistry, the object being to ascertain whether or not the fibrous portions of various crops can not be more generally utilized in the manufacture of paper. In this series of tests corn, rice, and flax are receiving prominent attention. It is too early to make a full statement, but the results already obtained are regarded as promising.

FRUIT INVESTIGATIONS.

Important work in connection with the pomological collections and other investigations of this nature has been carried on during the year. The Department receives many hundreds of requests for help, all of which are cheerfully met. The identification of fruits and the resulting correspondence occupy a great deal of time. More than 2,500 specimens of fruits were received for identification, including rare and little-known fruits from recently annexed island posses-

sions. More than 50 varieties of fruits were disseminated to fruit growers and horticulturists for trial during the year.

FRUIT MARKETING.—The investigation of the problems involved in the marketing, transportation, and storage of fruits has continued during the year, the work being shaped to conform to the rather abnormal crop conditions that prevailed during the season of 1907. Notwithstanding the low quality of the winter apples throughout most of the eastern apple districts, the export movement was heavy, and under existing market conditions again demonstrated its importance to the apple industry by affording an outlet for surplus supplies. The season's experience resulted in a renewed interest among growers and shippers in the subject of grading and packing winter apples.

HANDLING AND SHIPPING CALIFORNIA ORANGES.—The work on orange handling in California was vigorously prosecuted along lines previously discussed, with a view to accumulating sufficient data under varying conditions to permit safe generalization. In this work nearly 300 experimental shipments from California to the Atlantic coast were made in cooperation with individual orange growers and cooperative associations to determine the influence of different methods of handling upon the behavior of the fruit while in transit and after its exposure in the market. The results of this work in connection with that of former years establish conclusively that it is practicable to handle the orange so carefully on a large scale that decay in transit and for a reasonable time after arrival in our eastern markets can be practically eliminated.

FLORIDA ORANGE WORK.—The results of the work on orange handling in Florida, which has followed the general lines developed in California, indicated that the need of careful handling and prompt shipment after harvesting of the fruit from that State is even greater than with California fruit. The indications are that the losses there, which amount to a half million dollars a year, can to a considerable extent be overcome by handling the fruit with sufficient care to avoid mechanical injury. The work is receiving hearty cooperation from the growers and shippers of the State.

FRUIT STORAGE.—Comprehensive tests of the behavior of apples in storage from different producing sections in New York, Iowa, Colorado, and California have been continued with a view to determining the best methods of handling the fruit to insure the longest keeping in sound and wholesome condition. Strikingly important results have been obtained in the storage of a number of varieties of table grapes in California, which it has been found possible to hold from sixty-five to one hundred days in excellent condition when packed in fine ground cork, where similar fruit packed in the ordinary commercial way could be held but from ten to twenty days. The possibility of displacing the present large importation of foreign grapes for winter use with fresher fruit of better quality and of American production renders this work of special importance to American grape growers.

PECAN CULTURE.—Comprehensive studies of the adaptability and relative value of pecan varieties in the Southern States have been commenced, many problems requiring attention having come to light in connection with this rapidly developing new industry.

THE PASTURING OF RANGE SHEEP IN COYOTE-PROOF INCLOSURES.

An experiment in the pasturing, as opposed to the herding, of range sheep has been in operation during the past season, conducted jointly by the Forest Service and the Bureau of Plant Industry. The results of the experiment are of great significance in their bearing on the increase of the carrying capacity of the great sheep ranges in the Western States and on the improvement of range mutton and wool in amount and quality.

The experiment was located at Billy Meadows, in the Wallowa National Forest in northeastern Oregon, a district infested with coyotes and other wild animals. An area of 2,560 acres of mixed forest and grass land was inclosed with 8 miles of woven and barbed wire fence believed to be coyote-proof. The inclosure was cleared of coyotes in the spring and a band of ewes and lambs numbering 2,209 was turned loose within it. They were not herded, but were left entirely free to make their own choice of feed, watering places, and bed grounds.

The experiment was a success in every way. Although coyotes came up to the outside of the fence nearly every night during the summer, not one of them succeeded in entering the inclosure. The sheep spent the whole season in almost absolute quiet, without any molestation by wild animals.

Still more significant was the condition of the sheep at the end of the season. The pastured band was made up of original Merino stock bred for six years to Rambouillet bucks. The sheep were therefore of a pure fine-wool type. The average weight of the lambs at the age of 6 months was 72 pounds. Individual lambs weighed 90 pounds. In the unfenced range immediately adjoining the pasture a band of sheep of similar class and grade was grazed during the season under the customary herding system. This range was exactly similar to that in the pasture and had the advantage of being a little less heavily stocked. The lambs of this band averaged 62 pounds, 10 pounds less than the pastured lambs.

In the matter of carrying capacity a still greater economy was effected. A comparison of the pasture with the ranges of five bands immediately surrounding it indicates that the carrying capacity of the land was increased 50 per cent, at a conservative estimate, by the pasture system.

GRAIN STANDARDIZATION.

Since the publication of my last annual report an unusual development has taken place in the work of grain standardization. The results already accomplished have been of value in bringing about a better understanding concerning the value of the various factors which are taken into consideration in determining the grade of any given lot of commercial grain, and have led to the formulation of more definite and satisfactory rules on grades in many of the markets.

GRAIN STANDARDIZATION LABORATORIES.—Seven laboratories are now maintained outside of Washington, one at each of the following grain centers: Baltimore, Md., New Orleans, La., New York, N. Y., Duluth, Minn., Minneapolis, Minn., Chicago, Ill., and St. Louis, Mo. Numerous requests for the establishment of laboratories in other important

grain markets have been received, but the limited funds available for this work rendered the opening of additional laboratories impossible; consequently the work has been limited to the primary markets, embodying the widest range of conditions and showing the greatest variation in the kinds and classes of grain handled. In each of the laboratories now in operation the work consists principally in determining the moisture content and in making mechanical analyses of samples of grain submitted by grain inspectors and merchants, and in carrying on such special investigations in cooperation with the research laboratory which is maintained in Washington as will furnish data of value in adjusting the unsatisfactory conditions now existing in the grain trade throughout the United States. The moisture test is most frequently called for, and large quantities of corn are now handled on a definite percentage statement of moisture content. A number of cases have been reported in which the results of the analyses furnished by the laboratories have determined the action taken in appeals and otherwise served in the satisfactory adjustment of grades.

GRAIN TRANSPORTATION AND STORAGE INVESTIGATIONS.—Within the past year some preliminary investigations were made on the changes which take place in grain while in storage and during shipment from country points to primary markets or to the seaboard. These investigations will be carried on more in detail during the coming year, giving special attention to the causes of the deterioration of corn during transit from the central part of the corn belt to the seaboard and thence to European ports.

INSPECTING AND GRADING COMMERCIAL GRAIN.—While many of the influential grain dealers of the country are working hard to bring about a more satisfactory and uniform system of inspecting and grading grain in the various markets, it is believed, as stated in my last annual report, that the end to be attained can be brought about only through National inspection of all grain entering into interstate and foreign commerce.

MEASURING MOISTURE CONTENT BY ELECTRICITY.—As a result of work conducted by the Bureau, an electrical method for the rapid measurement of the moisture content of grain, requiring only two or three minutes for a determination, has recently been devised. This method can be used in cars and elevators and will doubtless prove of great value in connection with the grading of grain.

DRY-LAND AGRICULTURE.

This important work, inaugurated several years ago by the Bureau of Plant Industry, is being pushed as rapidly as the means at hand will permit. The work covers three principal areas: (1) The Great Plains region; (2) the southwestern section, including the dry portions of Texas, New Mexico, Arizona, and California; and (3) the intermountain region, including the Great Basin of Utah and the arid lands which can not be irrigated throughout the mountain States of the West. A number of the branches of the Bureau are contributing to the work and all are in close cooperation.

STATIONS FOR THE INVESTIGATION OF DRY-LAND CONDITIONS.—Eleven stations have been established in the Great Plains area where carefully planned scientific investigations are being carried on to determine the best methods of tillage, rotation, and crop sequence. Seven

of these stations are in cooperation with the State experiment stations of Montana, North Dakota, Nebraska, and Kansas. Four of them are not in cooperation with the State experiment stations and are located in South Dakota, Colorado, and Texas.

FARM MANAGEMENT.

The work which has now been carried on for several years under the general head of "Farm Management" is growing in importance and value. Its object, as previously explained, is to bring together and carry to the man on the land the best knowledge of how to make agriculture more profitable and at the same time conserve or build up the fertility of the soil. Research and experiments are not a part of this work, but the results secured in this field by the Department and the experiment stations are applied. The work is distinct from that of cooperative farm demonstrations, as explained under another heading, in that the class of farmers dealt with have, owing to more fortunate surroundings, been placed in a position to undertake advanced lines in the general improvement of agricultural practices.

Work in the South.—The continued clean cultivation of cotton and corn in the South has destroyed the humus of the soil. Special attention has been given to methods of supplying humus. Improved systems of crop rotation and general farm management are being outlined and put into practice by many farmers who are cooperating in a very cordial way with the Department. Crops which have been secured by other branches of the Department are called to the attention of reliable men who are willing to test and try them, and in this way various cereals, forage crops, etc., have been quite generally extended. In handling work of this kind every important factor which may bear on the successful production and handling of the crop must be taken into consideration. Alfalfa is being advocated in a number of sections with excellent results.

Work in the Middle West.—The continued advance in the price of land is having a marked effect on the systems of farming. In addition, the exhaustion of the soil under exploitive systems of farming has brought about radical changes. A special line of work conducted during the year has for its object the investigation of the possibilities of introducing successful agriculture in the jack-pine plains of Wisconsin, Michigan, and Minnesota. These lands are wild and sandy, and under ordinary methods of cropping are not profitable. Certain systems of farming, involving the growing of clover for seed, are found profitable in the region. A bulletin outlining this important line of work has been published.

Work in the Plains Region.—With a view to rendering assistance to the many people who are giving up their farms in the more humid regions and securing cheaper lands in the dry sections of the West, studies of successful farms in these drier regions are being made. During the present year the Department has been making a careful study of the experience of a number of farmers who have remained on the land since the first settlement a generation ago. Some of them have worked out satisfactory methods of farming in regions where farming generally has not been successful. The experience of these men will be brought together and published in the near future for the benefit of others who are trying to make a living under these adverse conditions.

FARMERS' COOPERATIVE DEMONSTRATION WORK.

The object of the farmers' cooperative demonstration work now being carried on in the South by Dr. S. A. Knapp is to place a practical object lesson before the farmer, illustrating the best and most profitable method of producing the standard farm crops and to secure active participation in such demonstrations by the farmers themselves. It is an effort to teach the farmer to help himself through the influence of good local assistance, aided and guided by such means as the Department may find it necessary to supply.

The practical value of the work can be estimated by its growth. Congress has made a yearly appropriation for its maintenance in the States where the Mexican cotton boll weevil is present, and the General Education Board of New York, being impressed with the results, asked to cooperate with the Bureau in extending the work east of the Mississippi. Beginning in 1906, this Board has supported the eastern or "extension division" of the work, which includes the cotton States from Mississippi to Virginia, by an appropriation annually increased till the sum of $76,500 has been allowed for the year 1908–9. From one farm in Texas and one agent in 1903 the work expanded in 1908 to 32,000 farms with 157 field agents, covering portions of 11 States from Texas to Virginia, inclusive. In numerous cases, when appeals were made for greater extension of the work and there were not sufficient available funds to meet the added expense, counties or business organizations have cooperated in paying half or more of the salary of an agent. As organized under the Bureau of Plant Industry, its working forces consist of 1 director, with assistants, 10 State agents, and 147 district and local agents. Weekly reports are made by all agents to the director, showing work accomplished each day.

It is stated to the farmers that they can increase their crop yields two, three, or four fold at a reduced cost per acre, and that this may be almost a net gain by producing upon the farms the food supplies for family and teams. They are asked to prove it by working an acre or more according to directions. The necessary work on this part of the farm must be done by the farmer and not by a Government agent, because the whole object lesson is thereby brought closer to the people. The demonstrating farmer understands it better because he does the work. His neighbors believe that what he has done they can do. The agent makes monthly inspections of fields and gives additional instruction.

In order to promote the successful development of the new projects put under irrigation by the Reclamation Service, this Department has started experimental work on several projects in the Western States. On three of these projects small experiment farms have been established during the past two years. The use of the necessary land, water, and permanent equipment for these farms is furnished by the Reclamation Service, and the experimental and demonstrational work is carried on by this Department. The aim of these experimental farms is to secure thorough and careful trial of new plants that are introduced by the Department, to ascertain and demonstrate the tillage and irrigation methods best suited to each locality, and to provide a place for the special investigators of the Department to carry on field experiments along their particular lines. As an instance of

the value of these farms in the introduction and establishment of new crops there may be noted the case of Egyptian cotton in the Southwest, an account of which is given on page 24.

ARLINGTON EXPERIMENTAL FARM.

The plan of soil improvement adopted in the management of the Arlington Experimental Farm is proving to be more effective than was anticipated. The work forcibly demonstrates the value of cowpeas and crimson clover as soil enrichers. The nitrogen gathered by these crops, together with the mechanical benefits obtained from turning under large quantities of organic matter, has transformed a cold, inert, and unproductive soil into one which is loose, friable, and productive. This work is of great value, because it demonstrates the method which any land holder in the South Atlantic States may follow to restore high productive power in his soil at small cost.

CONGRESSIONAL SEED DISTRIBUTION.

The Congressional distribution of seeds and plants was carried out along the same general lines as in previous years. The regular distribution of standard varieties of vegetable and flower seeds was made, and the cooperative distribution of selected varieties of cotton, tobacco, and other seeds developed by the Department was carried on with gratifying results. The work of packeting and mailing vegetable and flower seeds was seriously interrupted in November, 1907, by the almost complete destruction by fire of our seed warehouse. Congress promptly appropriated a sum sufficient to cover the loss, however, and the work was resumed about January 1, 1908, in temporary quarters. All of the vegetable and flower seed was distributed in ample time for spring planting in the various parts of the country, although the fire resulted in delaying the final shipments about one month beyond the usual time for completing the distribution.

FOREST SERVICE.

PROGRESS IN NATIONAL FOREST ADMINISTRATION.

Mastery by the Forest Service of one of the greatest practical forest problems ever undertaken by any Government is advancing apace. Briefly stated, that problem is to develop to its highest usefulness a total area of 168,000,000 acres of wild lands, mainly mountain wilderness, but closely related to the welfare of the entire West, and therefore of the entire country. The progress of the year was marked along both administrative and technical lines.

From an administrative standpoint the most striking fact of the year was the remarkable increase which took place in the volume of business transacted, or, in other words, in the actual use of the Forests by the public.

Regarded as property, the National Forests justify liberal expenditures for their protection and improvement. At $2 per thousand feet stumpage, the merchantable timber alone forms, just as it stands, an asset worth something like $800,000,000, while the very moderate grazing charge yielded the Government last year an income of nearly $1,000,000. It is a safe prediction that within twenty years the For-

ests will bring in from the sale of timber alone an annual net income of as many millions of dollars.

An average wood production of 30 cubic feet to the acre of commercial forest is a moderate estimate of what will ultimately be obtained under management. One hundred million acres of such forest would allow to be cut each year over 3,000,000,000 cubic feet, or from 20,000,000,000 to 25,000,000,000 board feet, without diminution of the supply. This is but a fraction of the country's consumption of wood at the present time, but at the stumpage prices which already obtain in the older and better settled parts of the United States its sale would bring the Government each year from $80,000,000 to $125,000,000.

WHY EXPENDITURES EXCEED RECEIPTS.

Were it wise to do so, the receipts from the Forests could very easily be made not only to keep pace with the expenditures, but to return to the Government the entire cost of maintaining the Forest Service. Private owners of grazing lands in the same regions ask and receive a very much higher return per head of stock for the use of their lands than does the Forest Service. The National Forests, which contain one-fifth of the standing merchantable timber in the country, furnished last year about 1.3 per cent of its lumber cut, resulting in the removal from the Forests of about one-eighth of 1 per cent of the stand. Of this comparatively insignificant amount cut, one-fourth was not sold, but was given to home builders and communities; yet the sales brought in nearly $900,000. If the chief object of the Forests were to produce immediate income, the amount received could be multiplied several times. There is actually going to waste in the woods each year, through decay and other natural causes, from five to ten times the amount of timber now being cut.

With an adequate force of Forest officers available much of this waste might be prevented. Timber sales involve, for marking, scaling, and supervising the work, a cost to the Government of about 30 cents per thousand feet, and the amount sold can not be much increased without an increased appropriation. There is also the waste of the productive power of the Forest, which can not be brought into full play until the mature trees have been removed to make room for a growing crop.

Yet other considerations are involved. Most of the National Forest timber is beyond reach unless heavy outlays are made to obtain means of transportation. Such timber can be sold only to those who command large resources of capital, and even then only at a relatively low price. On the other hand, where the demand for the timber is good and competition for its purchase fairly brisk, it is generally necessary to go slowly because of the certainty of future requirements. In short, the question of the timber that can safely or wisely be sold is a local one. The fact that timber is rotting in the woods in distant regions will not help communities which find their home supply exhausted.

For these reasons the sales of National Forest timber are carefully guarded. In consequence the receipts have for the time being lagged behind the expenditures. In 1907 the Forests brought in more than was spent upon them. In 1908 the expenditures exceeded the receipts by more than $1,200,000. The difference in the showing of the

two years is a result of the recognized necessity of considering future needs in preference to immediate revenue. That the country may have timber when it will want it most, the Government is virtually investing the difference between the receipts and the expenditures, for it is not merely protecting the present merchantable timber from loss by fire, but is also increasing the stock of young trees which will make up the future Forest supply.

I am now restricting the sale of timber from the National Forests in accordance with a policy dictated by the public interest. The timber lands of the West, outside of the National Forests, are mainly in strong hands. Were the National Forest timber offered on the market to every purchaser, the main scene of western lumbering would be quickly shifted to the public holdings.

PERMANENT IMPROVEMENTS.

The agricultural appropriation act of 1908 included an item of $500,000, which was made available for permanent improvement work on the National Forests. The object of this work is to help open up the Forests to more use and provide means for their better and more economical protection, through the supply of means of communication and transportation, well-located field quarters, fire lines, fences to assist in the handling of stock, and watering places. These improvements are essentially investments of capital, which add greatly to the value and usefulness of the Forests.

The work completed during the year included 3,400 miles of trails, 3,200 miles of telephone line, 100 miles of wagon road, 40 miles of fire line, 250 bridges, 550 cabins and barns, and 600 miles of pasture and drift fences. In addition to the sum provided by the special-improvement fund, over $100,000 from the general fund of the Service was turned from current expenses to defray the cost of this work, but much of the work planned and urgently needed could not be carried out because there was nothing with which to pay for it.

THE ADVANCE IN TECHNICAL METHODS.

All timber to be cut is marked beforehand by the Forest officers. The efficiency of this work depends on the wisdom with which rules for marking are laid down and the skill with which they are applied. In both respects the work of the year bettered previous practice. Special marking rules for each National Forest were prepared and put in force. Where it was found that a shortage of the supply of timber for meeting local needs is to be feared, the marking system was modified to provide for the cutting only of trees which have made their full growth or are dying or diseased. Thus, the thriftier merchantable trees are left for a second cut from the same area within fifteen or twenty years. The selection of seed trees was improved, more complete use of the timber felled was secured, and more dead and low-grade timber was sold. In these and many other ways the standard of technical work on the Forests was raised.

The fire record also deserves mention. Since the fiscal year ends in the midst of the fire season, reports of fires are made not for fiscal but for calendar years. During the calendar year 1907 the loss of timber by fire was less than half that of the previous year, though this

in turn was less than ever before. About one-seventh of 1 per cent of the Forests was burned over in 1907, with a damage so slight as to be practically negligible. The ratio of loss to the value of the timber protected, allowing that it is worth $2 per thousand feet, was about as 4 cents to $1,000. The entire cost of National Forest administration was equivalent to a charge of one-third of 1 per cent on the value of the timber protected—surely a cheap insurance rate.

THE NEED OF PRIVATE FORESTRY.

Ten years ago the Department of Agriculture offered, in pursuance of investigations in forestry, and in order to disseminate a knowledge of improved ways of handling forest lands, to cooperate with private owners through expert advice and assistance in planning and putting into practice forest management for their holdings. The investigations thus made possible were of the first importance. But for them the Government would have been altogether unprepared to undertake six years later the scientific management of the National Forests. They were in fact the foundation and virtually the beginning of practical forestry in the United States.

This offer has never been withdrawn. The work which its fulfilment involved was the chief cause of the rapid growth of the Forest Service between 1898 and 1905. Since 1905, however, the necessity of providing first of all for the needs of the National Forests has compelled curtailment of expenditures for general investigations, since neither men nor money have been available to carry them on.

NATIONAL FOREST ADMINISTRATION.

The number of National Forests under administration at the beginning of the year was 169, and at its close 182. In both cases the only National Forest not under administration was the Luquillo, in Porto Rico. The administrative, executive, and protective force numbered 1,512 at the beginning of the year, and 1,961 at the end.

Certain lands within National Forests are covered by unperfected claims. Under the general land law such claims can be initiated only under the mining laws, or for land which is found by the Secretary of Agriculture to be chiefly valuable for agriculture, and which is recommended by him to the Secretary of the Interior for listing for settlement and entry. Claims initiated before the National Forests were created, mining claims, and claims for agricultural land listed as above may be perfected in exactly the same manner as claims for lands outside of the Forest. All questions of compliance with the land laws are by law within the jurisdiction of the Department of the Interior. Since the duties of the Forest officers require them to be familiar with the land embraced within National Forest claims, the Secretary of the Interior has requested this Department to make reports of such conditions, and Congress has authorized the Forest Service to assist the Department of the Interior by ascertaining and reporting the actual facts on the ground. Since few Forest rangers have a practical knowledge of mining, the Forest Service has called to its assistance geologists from the United States Geological Survey, and has employed mining engineers and practical miners to make reports upon mining claims. During the past year reports were made to the General Land Office on more than 6,000 claims for lands in

National Forests. Of such reports 76 per cent were favorable. Action by the General Land Office, which resulted from reports made for several years previous, resulted in the cancellation of invalid claims to 50,000 acres of land bearing over 330,000,000 feet of merchantable timber. Every precaution is taken to avoid injustice to those holding claims. The claims which have been canceled by the Department of the Interior are those which were made for speculative purposes, and not for the permanent development of the lands. This work of examination is producing good results and is promoting the bona fide development of farms and mines. It increases the burdens which rest upon the National Forest force, but the expense to the Government occasioned by such examinations is repaid many times by the land and timber saved from speculative and fraudulent claims.

Examinations of lands under the act of June 11, 1906, led to the listing for settlement of about 240,000 acres of National Forest land.

The amount of National Forest timber sold during the year was slightly over 386,000,000 feet, or not much over one-third the amount sold the previous year. The falling off was directly due to the refusals to make large sales. Under such sales the actual cutting is allowed to extend over several years. The amount of timber cut and paid for during the year, however, more than doubled the cut of the previous year, with a total of not quite 393,000,000 feet. The receipts from timber sales were about $850,000, as against not quite $670,000 for the previous year. In addition there was cut under free use over 130,000,000 feet of timber, valued at about $170,000.

Reforesting of large areas of the National Forests is called for primarily in the interest of the water supply of the West, but also, though less pressingly, for the sake of an enlarged timber supply. Broadcast sowings were made during the year in 27 Forests, in 8 States, to test by experiment the extent to which reforestation may be hoped for through the use of this method. The National Forest nurseries in which are being grown stock for transplanting were enlarged and about 700,000 trees were planted. Over 2,000,000 trees will be ready for planting in 1909.

The beneficial results of regulated grazing, shown in a decided betterment of much of the National Forest range, made it possible to increase the allotment of stock on a number of the older Forests. At the same time investigations in range improvement through reseeding, new methods of handling stock, the eradication of poisonous plants, and the destruction of prairie dogs brought important progress toward still better future use of the Forests by stockmen.

BUREAU OF CHEMISTRY.

The report of the Chemist records the progress made during the first year of the execution of the Food and Drugs Act. The manifold difficulties in the organization and inauguration of such a work are apparent even upon superficial consideration of the subject; and, when one considers the scientific problems involved, the necessity of training the majority of the increased force, whether scientists or inspectors, and the double duty of securing justice for the manufacturer and the consumer alike, it is apparent that it is the part of wisdom to make haste slowly, particularly in regard to some decisions which are especially far-reaching in their effects. In putting the law into operation, every effort has been made to avoid working hard-

ship upon any one. The decisions of the Board of Food and Drug Inspection as reached have been issued in a series of leaflets and have been widely distributed to manufacturers, dealers, and importers, that they might be aware of the attitude of the Department in regard to the points raised. At the same time much of the moral effect of the law depended upon a vigorous enforcement of its provisions, and such enforcement was plainly due the consumer for the protection of his health and his purse. It has been the endeavor of the Department to pursue a purely impartial and equitable course, giving due weight to all of these considerations.

INSPECTION UNDER THE FOOD AND DRUGS ACT.

A statistical statement of the samples taken and analyzed, seizures made, and prosecutions brought conveys practically no idea of the volume of work involved or the effect produced on the quality of food products. The number of branch laboratories has increased from 6, examining only imported products, to 21, analyzing both interstate and foreign samples. These laboratories are located at the following points, selected because of the control afforded interstate commerce: Boston, Buffalo, Chicago, Cincinnati, Denver, Detroit, Galveston, Honolulu, Kansas City, Mo., Nashville, New Orleans, New York, Omaha, Philadelphia, Pittsburg, Portland, Oreg., St. Louis, St. Paul, San Francisco, Savannah, and Seattle. The number of inspectors was increased during the year to 39 and approximately 13,400 samples have been collected and distributed among the branch laboratories and to the Division of Foods and the Division of Drugs of the Bureau of Chemistry. Inspectors are assigned to the branch laboratories and to such other points as afford an advantageous situation in regard to the interstate distribution of supplies. Of the samples analyzed and found to be adulterated, 814 were found to have been collected under such conditions that prosecution could be brought.

In addition, the inspectors have collected data necessary to institute proceedings for the seizure of 86 shipments for confiscation by a process of libel for condemnation. The shipments include cider, honey, coffee, flour, canned fruit, sirup, molasses, wine, meal, beer, vinegar, stock feed, and canned vegetables. These seizures usually represent large quantities of the products, as, for example, 135 barrels of cider, 40 cases of coffee, 2,240 sacks of flour, or 1,078 barrels of wine. In some cases the shipment was destroyed, for instance, 84 bags of coffee colored with lead chromate. In many other cases, where only misbranding is involved and this may be corrected by relabeling, the goods are returned to the owner upon payment of costs and the delivery of a bond not to dispose of the product contrary to the law. This feature of the law has not proved uniformly desirable, inasmuch as the manufacturer has in some cases failed to comply with the terms of the bond, necessitating an additional expenditure of labor and money for his reapprehension.

In addition to the collection of samples, the investigation of factories and work in cooperation with the chemists of the branch laboratories in conducting special investigations have played no small part in the activities of the inspecting force. The routine collection

of samples of misbranded whiskies was supplemented by a special effort to locate large shipments of the product manufactured from neutral spirits and misbranded, under the decision of the Attorney-General, as straight whisky or blended whisky. Seizures have been made to the extent of 82 barrels and 6,702 cases, action in regard to the greater part of which is pending, and libel proceedings have been requested affecting 625 barrels and 31,359 cases of food and drug products.

SPECIAL FOOD AND DRUG INVESTIGATIONS.

A cooperative investigation in regard to the bleaching of flour and the use of durum wheat in flour milling was undertaken at the St. Paul, Chicago, and Washington laboratories, with the aid of the inspectors. In regard to the use of durum wheat, the leading millers were interviewed, the composition of 47 samples was determined, and a study was made of wheat mixtures affording information which had been much needed in regard to the branding of wheat flour. Seizures have been made and judgments obtained as to the misbranding of wheat flours which were mixed with flour from durum wheat and labeled hard spring wheat flour. The investigation in regard to bleaching flour was more extensive, as it called for a thorough study of the methods of grading and the results of baking tests, as well as chemical and physical examinations, before a conclusion could be reached. Over 1,000 determinations have been made in this study, and the investigation is nearing completion.

Special investigations, combined with factory inspection, have been made in regard to the canning of peas and the making of tomato ketchup. In the former case studies as to the grading of the product in connection with the question of proper branding have been made, and the effects of bleaching and the causes of spoilage have been studied. The ketchup experiments were made at a factory offered for the purpose, and included the manufacture of ketchup without preservatives, the causes of spoilage, the length of time elapsing both before and after opening when spoilage would take place, no preservative being present. Studies were also made of the antiseptic value of the spices, sugar, and vinegar employed. Methods of processing were also studied, and commercial brands were examined and compared with the experimental product. In connection with these studies it is of interest to note the increasing importance of the microscope in the detection of adulteration, the presence of bacteria, fungi, and other signs of fermentation and decay being easily demonstrable by micro-chemical examination.

The investigation of imported drugs involved the examination of 568 samples, representing many phases of adulteration and misbranding.

The examination of chemical reagents delivered to the Bureau of Chemistry is a very important item, underlying as it does the accuracy of the analytical work, and marked improvement has been effected in the quality of the chemicals delivered.

MISCELLANEOUS INVESTIGATIONS.

Numerous other investigations are in progress which are called forth by commercial conditions or are rendered necessary by the

exigencies of the administrative work. The following are selected for comment as illustrative of the scope of the work:

POTABLE WATERS.—The extent to which mineral waters are being used rendered an examination of these products as they enter into interstate commerce advisable. Examinations accordingly were made of samples obtained at the sources of the waters and also as bought on the market. While it would be unfair to imply that the majority of these waters are sophisticated, nevertheless it has been found that a goodly number are contaminated in handling, as shown by the bacteriological findings, or are not true to label. The latter is especially apt to be the case in regard to mineral waters, the content of special constituents supposed to have medicinal value being very small. As bottled waters are depended upon for special purity and for use in illness, it is plain that a high standard should be maintained and the product should be true to label. The object of the investigation under way is to assure the public that potable waters in interstate commerce may be depended upon in these particulars.

UNFERMENTED FRUIT JUICES.—Experiments in the manufacture of unfermented fruit juices without the use of preservatives have been conducted on an extensive scale. Tests of methods of manufacture and of storage in glass, in tin, and in wood, including shipping tests, have been made, and it has been positively proven that palatable beverages may be made and may be kept by sterilization by heat only. This work is of interest both to the manufacturer and to the farmer, who can make profitable use of fruit products not marketable and which in most cases go to waste.

HONEYS.—A chemical and microscopical study of honeys of known origin and of commercial honeys had a direct bearing on the questions arising under the food law in regard to interstate samples. Careful studies of methods of analysis were made for the determination of adulterants, and the microscopical studies serve to identify the honeys as to their source by ascertaining from the pollen grains present the plants visited by the bees, the labels generally stating that the honey is from some particular floral source. Seizures of honey containing invert sugar and glucose have been made, and the data obtained in this investigation were needed for practical application.

COMMERCIAL ALCOHOL.—The study of the manufacture of industrial alcohol from the wastes of the farm and of sugar-producing plants has been inaugurated on a large scale. A plant manufacturing 75 gallons per day has been installed, and experimental runs, using corn, melons, small fruits, canning wastes, etc., will be made on a commercial scale. From these experiments it is expected that calculations can be made as to the comparative value of different wastes and materials for this purpose.

WORK IN COOPERATION WITH OTHER DEPARTMENTS.

While special investigations have for many years been conducted in cooperation with certain Departments, the practice of referring miscellaneous samples to the Bureau of Chemistry for analysis is constantly increasing, and there is hardly a Department for which some work is not done.

In regard to the drug work it is believed that the centers of propagation of fraudulent remedies and "cure-alls" have been broken up, and that in time this far-spreading evil will be practically destroyed so far as the mail service is concerned.

BUREAU OF SOILS.

To the Bureau of Soils is intrusted the study of the soil resources of the United States. There are three important steps in such a study. The first is to ascertain accurately by actual field investigation the extent, the location, and the boundaries of each and every distinct soil type in the country and to state its actual condition and efficiency as a factor in the annual production of new agricultural wealth. This work is being accomplished through the soil survey.

The second step is to ascertain those properties of soils, physical, chemical, and organic, which render each soil fitted to continue to produce profitable yields of crops, and to ascertain by what methods of cultivation, crop rotation, and fertilization the efficiency of each soil may be maintained and increased. This work is being done by the laboratories of soil physics, soil chemistry, and soil fertility.

The third step is to study all processes by which the actual soil substances are wasted or their properties essential to crop production are impaired, and to devise methods whereby such waste and impairment may be decreased or totally prevented. This work is being done through the investigations of the greatest source of soil wastage—soil erosion.

SOIL SURVEY.

The work of the soil survey was actively begun in 1899, when Congress first appropriated money for the purpose of making soil surveys. Since the inception of this work there have been surveyed 306 different areas in 44 different States and 2 Territories, exclusive of one area in Porto Rico. A soil survey is now in progress in one of the two remaining States, and one will be completed during the present fiscal year in the other State.

A total area of 157,078 square miles, or 100,529,920 acres, has been included in this work, and the Bureau of Soils maintains a field force of 62 men, working in different parties and completing detailed work in about 60 different areas, covering a total area of approximately 40,000 square miles each year.

In addition, reconnoissance surveys of 135,000 square miles annually are being conducted in the Great Plains and in the Appalachian Mountain and Plateau regions.

There are on file at the office of the Bureau of Soils requests for 478 additional soil surveys, covering nearly 500,000 square miles of territory.

A soil survey determines the exact character of the various soils, and their location and extent in each area is studied. It also ascertains their present use and capabilities by personal observation of the field force and the report of practical farmers owning and operating the soils and the farms investigated. It summarizes all of the present knowledge of these soils, whether obtained from the farmers who are cultivating them, from the chemical, physical, and fertility investigations of the Bureau's laboratories, or from the experimental and research work of the various State institutions concerned. It also enables all soil investigators and agricultural experimenters, as well as the farmers, to make direct comparisons between the soils of any one locality and of all others in the United States.

PROBLEMS IN THE USE OF SOILS.

The great problem of the northeastern States is so to utilize their soils that they may produce upon an intensive scale those crops which yield large returns per acre, which have a particular market value in the great seaboard cities, and which may be produced practically without competition from the more level central prairie States. The great variety of soils in the northeastern States and the fact that they have been farmed for two centuries practically to grass and grain crops makes it necessary to show the farmers of the section that these soils have other higher values than the production of the cereal crops and hay. Any change which may be brought about by this knowledge will be slow and gradual, and it is necessary first to demonstrate the desirability of such changes and then their possibilities.

In the South Atlantic States the problems are similar, except that large areas of unoccupied land still exist, and that the problem of the drainage of a portion of these lands along the coast and the determination of their crop value is paramount. Farther inland, in the Piedmont section, the prevention of soil erosion is one of the chief problems.

In the Gulf States the development of special industries along the coast is showing uses for lands which have previously been considered of little or no agricultural importance, and lands once held at a nominal value for their timber stand now have a greater value as agricultural lands even after the timber has been removed. This is largely due to the fact that their agricultural uses have been shown by a number of well-located soil surveys.

The problems of the central prairie States have in general been well worked out by the farmers of those States, and, until economic conditions in the United States change, the chief value of the soil surveys in the different States will be to enable the farmers to compare directly the best methods to be employed in the handling of their different soils. The other important problem is to determine the character of the soils in the vicinities of the large cities, in order that a local market-garden supply of vegetables and fruits may be raised near to the point of consumption. The greatest problem of the Upper Lake region is to determine the extent of agricultural lands and their uses in the cut-over timber belt.

In the far West the opening of Indian Reservations and the extension of irrigation systems annually make available for agricultural purposes large tracts of land about which there is little or no information, so far as the nature of the soil and its peculiar fitness for various crops is concerned. The change from extensive grain farming to intensive methods of agriculture in the fertile valleys of California and Oregon is likewise making available large tracts of land that under the changed conditions will support a population many times as large as formerly. Expert knowledge of the soil and its power to produce fruit and truck crops is essential to make such worthy enterprises successful.

All new tracts of land of this character are widely advertised and the cautious home seeker avails himself of all information that will enable him to make a wise selection of soil. In such areas where soil surveys have been made the reports are eagerly sought for, but the increase in the number of new and favorable localities in the fast-

developing Western States emphasizes the necessity of making these additional soil surveys if the Department is to furnish this information to the farmer.

In Oregon and Washington, where the removal of the original forest growth has progressed sufficiently far to permit the farmer to engage in agriculture, the soils have yielded well all those truck and fruit crops which are in great demand in the Alaska mining districts. Additional surveys are needed in these northwestern forested areas to help the people to a better understanding as to just what these soils will produce.

The Bureau has continued active cooperation with the Reclamation Service in surveying the soils of the various projects under construction. This is likewise essential to the complete success of these undertakings on the part of the Government to make homes for the people in what are at present arid wastes.

RECONNOISSANCE SURVEY OF THE GREAT PLAINS REGION.

A noteworthy achievement just accomplished is the completion of a reconnoissance survey of an area of approximately 40,000 square miles in western North Dakota, in the Great Plains region. This region includes that portion of the country west of the one hundredth meridian and east of outlying ranges of the Rockies, extending from the Canadian boundary on the north to the Rio Grande on the south, and contains several hundred thousand square miles.

In my opinion this reconnoissance survey of the Great Plains should be vigorously prosecuted until complete knowledge of the soil conditions in the form of maps and reports for the entire region is available to all who wish to make homes in this section of the country.

LABORATORY INVESTIGATIONS.

The laboratories of the Bureau of Soils are maintained mainly for the support and aid of the field parties. During the past year they have accomplished a largely increased amount of detailed analytical work to this end, necessitated by the increasing activities in other branches of the Bureau's work. Besides this, however, the laboratories have continued their fundamental investigations on the relation of the soil to plant growth, some of the results of which it is proper to notice here.

It is now recognized that a farmer in handling his soil is in much the same position as the foreman of a factory, and to get the most out of his plant and raw material it is necessary to establish as perfect a control as possible of raw material, processes, and product. To obtain this control in the case of the soil, it is necessary to understand the fundamental relations between the plant, the soil, and the weather and similar conditions of environment, and the relation of one crop to another as affected by different types of soil, etc. In studying these problems it has come to be recognized that we must consider first three things: (1) The plant; (2) the soil moisture, which is the great food source of the plant; and (3) the mixture of solid mineral and organic compounds of the soil which determines the nature of the soil solution on which the plant feeds. These three things have this in common,

that they are always more or less in motion. The sum of these movements is within a few years astonishingly large, and there is a profound change as far as the individual particles of the soil are concerned in every field, subsoil becoming surface soil, surface soil removed or replaced by materials from divers places, etc.

These movements which lie at the basis of soil fertility and crop production are all more or less readily affected by the three practical methods of control which human ingenuity has devised—cultural methods, crop rotation, and fertilizers or soil amendments. These movements in turn determine the physical, chemical, and biological conditions in any soil and its suitability for the production of any given crop or rotation of crops. Broadly speaking, the investigations of the laboratories of the Bureau of Soils aim to elucidate and make clear, and if possible give quantitative expression to the interrelations between these fundamental and natural soil phenomena and the known methods of control, with a view to improving the latter, reducing them to a logical basis, and removing them from the condition of empiricism in which they have so long remained.

The relation of the physical properties of the soil to the moisture content has been further studied. It has been shown that there is a critical moisture content where the water in the soil ceases to be entirely in the form of films over the surface of the soil grains and some of it is in the form of ordinary free water in the interstitial spaces. Laboratory methods for determining this critical moisture content, with precision, have been developed, and it is now a comparatively simple matter to determine this important datum for any given soil.

It has further been shown that the diffusion of heat into a soil (a most important factor in the germination and early growth of a crop) takes place most readily when the moisture content is slightly greater than the optimum, but is greatly retarded by a content much above or below this point. This investigation has also brought out important information regarding certain special methods of cultivation, as the flooding of cranberry marshes, etc.

In connection with the work on soil erosion which the Bureau is carrying on, a laboratory method has been devised for studying and comparing the erosiveness of different soils, and it now appears, contrary to popular opinion, that the soils of our Southern States are not inherently different from northern soils in this regard, but that the greater amount and extent of soil erosion observed in the South is due mainly to the torrential character of the rains and other climatic conditions peculiar to that section, and to faulty methods of cultivation. Practical methods for preventing and remedying erosion are now well understood, and there is a very gratifying increase in their use.

While the great carrying power of water in effecting the translocation of soil material is obvious, the importance of the wind in this connection has not been so generally recognized. Important movements of soil material by water take place only occasionally, and then in restricted areas, as along river courses, etc., while the wind is acting practically all the time and throughout the entire extent of land surface. An important and careful investigation has been made by the laboratories this past year, which shows among

other things that the aggregate translocation of soil material by wind is many hundreds, perhaps thousands, of times that produced by water, and through incomparably greater distances.

An important and perennial subject of soil investigation is the organic matter in the soil known as "humus." Investigations of the physical and chemical properties of this substance have been continued during the year. It is a complex mixture, differing markedly in properties in different soils. The separation of the different components forming it has long defied the efforts of the chemist, but quite recently the laboratories of the Bureau of Soils have devised methods by which most gratifying progress is being made in this direction. It is not too much to expect that before many years the indefinite and rather meaningless term "humus" will disappear and we will speak of the different compounds forming it and their specific properties. Of these there appear to be two classes. The first includes the organic compounds common to most or all soils. So far as we now know these appear to have but little chemical or physiological effect on plants, but are mainly important for their physical effects on the soil. The substances of the second class are found in an individual soil or a few soils as a result of special conditions. Frequently these appear to have a profound and direct effect on plant growth.

In the fertility investigations of the Bureau of Soils some very important problems have been attacked and some very noteworthy results obtained which can not fail to be of the greatest value to further research in these lines and thus become of the greatest practical importance to the farmer. The soil investigator encounters many soils which do not respond to fertilizers, or if they have responded in the past, no longer do so at the present time, or at least require an entirely different system of fertilization from that necessary at the beginning. Fertilizers give in different seasons and in different years results which are not consistent but more or less erratic. The use of commercial fertilizers is constantly on the increase and conservative estimates place the expenditure at more than $100,000,000 annually.

It is this problem that has engaged the Bureau's attention for a number of years, and the extended use of commercial fertilizers in the United States makes it imperative that a thorough understanding of the action of fertilizers be obtained, for perhaps as much as a third of the money spent for fertilizers is annually wasted and brings no adequate return, owing to this lack of understanding of the soil's requirements. One of the most interesting results of this work has been to show that fertilizers have properties of improving soil conditions in addition to the plant food which they supply, and that in some cases this action may be of even greater importance as far as practical results are concerned than the plant food added. The Bureau's exhaustive studies in this difficult field have shown that in some of the unproductive soils this unproductivity is not due to the lack of any of the mineral plant foods, but is distinctly due to the presence of harmful properties which prohibit the plant from performing its normal functions when growing in the soil. The presence of these bodies in such soils has engaged the Bureau's attention for some time, and with the methods at its disposal it has been able to

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show that they exist, and that the soils and the extracts from these soils possess toxic qualities.

The most noteworthy advance in this work, and one which is of the greatest interest to practical agriculture, is that some of these bodies have now been actually isolated. They are not substances of mineral origin, but form a portion of the organic matter of the soil. It appears that in previous investigations of soils the organic matter has not been adequately considered, the investigators contenting themselves with determining the amount of organic matter present and the total nitrogen available in this organic matter. The researches of the Bureau therefore throw a great deal of light on the functions of organic matter in the soil. During the past year the Bureau has studied further this organic matter, with a view to determining its relation to the changes which are going on in every soil.

Other investigations of the Bureau during the past year have been the study of the influence of green manures and stable manure on plants and on the soil compounds. These researches have shown that properly decomposed green manure contains compounds which are beneficial to plant growth, aiding the plant to overcome any toxic conditions which may be in the soil in which it is grown to such an extent that a permanent effect upon the fertility of the soil is thereby brought about. The stable manure has been differentiated into organic and inorganic materials in the laboratory, and it has been shown that the organic materials have even greater influence in producing the healthful growth of crops than the mineral ingredients, although these aid materially.

The influence of bacteria on soil organic matter is another subject which demands further study, as the results so far obtained have shown that this action may be either direct or indirect, direct action resulting in the production of beneficial, harmful, or inactive organic compounds so far as crops are concerned, depending upon the conditions and the kind of bacteria at work. Bacteria also have an indirect effect, producing such products as ammonia, nitrites, and nitrates, and these affect the organic compounds of the soils. Still other factors of a biochemical nature must be taken into consideration. Experiments indicate a very strong influence of molds in the production of some of the bodies already isolated from the soil.

BUREAU OF ENTOMOLOGY.

The work of the Bureau of Entomology has increased in scope and efficacy during the year. Admirable progress has been made in investigations under way, and certain new topics have been taken up.

WORK ON THE GIPSY MOTH AND THE BROWN-TAIL MOTH.

The work of the Bureau against these two injurious insects in New England has consisted largely in clearing up the thoroughfares leading from the most seriously infested localities by destroying the underbrush, removing poor trees, and burning all débris for a strip of 100 feet on each side of the road. The forests in many places in Massachusetts are seriously infested, and the method just described renders them comparatively innocuous as centers of distribution, since the roads through these forests are so clean that the caterpillars

can not drop upon passing conveyances and thus become distributed over large areas. Scouting has been continued in Connecticut, Maine, New Hampshire, and Rhode Island, and every effort has been made to prevent incipient colonies from becoming dangerous centers. Extermination has been aimed at where possible, and prevention of spread where the colonies are larger. Work against the brown-tail moth has been carried on only along roadsides where work is being done against the gipsy moth. In Maine, Massachusetts, and New Hampshire there are State laws requiring property owners in cities and towns to care for this pest, and in those States occasional advice to property owners with regard to the removing of the winter webs is the main effort of the Government workers. One hundred and thirty miles of road in the State of Massachusetts has been cared for during the year in the way of cleaning up the border strips, both by banding trees and by spraying. The conditions in New Hampshire have been shown by scouting to be more serious than has hitherto been suspected, but in Connecticut, Maine, and Rhode Island extermination is still a possibility. The work has been admirably done, and commands the commendation of officials and citizens of the States in question.

IMPORTATIONS OF USEFUL INSECTS.

The main work in this direction has been a continuation of the large-scale efforts to introduce and acclimatize foreign parasites of the gipsy moth and the brown-tail moth in cooperation with the State of Massachusetts. Additional expert assistants have been stationed at the headquarters at Melrose Highlands, Mass., and a large amount of European parasite material has been brought over and in much better condition than in previous years. An expert has been sent to Japan who has organized an efficient service among the Japanese entomologists and has secured the sending to this country of many thousands of parasites belonging to several different species. At the parasite laboratory new methods have been devised, and it has been shown to be possible to breed both the European and Japanese parasites in large numbers in artificially heated rooms, and thus to liberate them in infested woodlands in much greater numbers than before. These discoveries reduce the expense of the experimental work and at the same time increase its efficiency. During the summer of 1908 more than 200,000 specimens of the most active foreign enemies of both gipsy moth and brown-tail moth have been imported and liberated under the most favorable conditions. In all 51 species of parasites and predatory enemies have been introduced, and all secondary parasites have been destroyed. Of the 59 species imported, there is sufficient evidence that 7 species have thoroughly established themselves. The probabilities are that many more have succeeded, but thus far it has been difficult to determine this point. There has been during the past year a tremendous destruction of the larvæ of both brown-tail moth and gipsy moth from bacterial and fungous diseases, and these diseases have in many localities killed off the parasites as well. The outlook for ultimate success is more favorable at the present time than at any period during the progress of the work. There seems no doubt whatever that eventually these imported parasites will multiply to such an extent as to render the gipsy moth and the brown-tail moth no more harmful than many of our native

leaf-destroying caterpillars, but the experts of the Bureau of Entomology can not fix the date at which this desirable condition will be brought about.

MEXICAN COTTON BOLL WEEVIL.

The work against this important pest has shown a number of promising features during the year. It has been found that native parasites are becoming much more effective in controlling the weevil. During the season the average parasitism has been shown to have doubled in Texas and trebled in Louisiana. Work has been carried on in the introducing of parasites from one region to another, with the result that in several cases the effectiveness of parasites has been greatly increased by the introduction of material from other regions. Studies of a native ant which is increasing in efficiency as a weevil enemy have resulted in the discovery of an especial method of attracting these ants to substances in which they will build their nests and in which they may be transported in enormous numbers into regions where they are not abundant.

An important apparatus for the control of the weevil has been invented and a patent granted thereon. At the instance of the Department of Agriculture this patent has been dedicated to the use of the public. The invention consists of series of chains attached to a light frame in such a way that when dragged between the rows the fallen cotton squares infested with weevils are removed from the shade of the plants and brought into a narrow pathway between the rows, where they are exposed to the direct rays of the sun. This destroys and very greatly increases the mortality of the weevils in fallen squares. The same machine has a very useful cultural effect—it fills up the cracks in the soil and establishes a perfect dust mulch.

It has been shown in the Mississippi Valley that the basic method of destruction of the weevil by the fall destruction of the cotton plants becomes even more important than it was in Texas. The large-scale demonstrations of the importance of this operation carried on by the Bureau of Entomology have been widely advertised in the Mississippi Valley, with the result that during the present autumn great interest was shown by the Louisiana planters, and in one parish more than 40 per cent of the planters undertook the fall destruction of plants, which gives great promise for the success of their crops the coming year.

INSECTS INJURIOUS TO FORESTS.

Extensive field investigations have been carried on in the National Forests of northern and central Utah, northeastern Oregon, southern Arizona, southern New Mexico, and throughout Colorado to determine additional facts regarding the distribution of the principal insect enemies of the Rocky Mountain forests.

It was determined by a thorough inspection during the last year that the efforts of private owners and forest officials during 1905–6 to control the alarming outbreaks of the Black Hills beetle in 1904–5 in the vicinity of Palmer Lake and Colorado Springs and the adjoining Pikes Peak National Forests, under the advice of the Bureau of Entomology, were a complete success. It was also demonstrated that, in the same way, the efforts of the owners of an extensive private estate

in Colorado to control the depredations of the same insect were equally successful. The first of these was accomplished by the cutting and barking of 1,000 trees, the products of which paid a large share of the cost and resulted in the protection of timber valued at more than a million dollars. The second was accomplished by the cutting and barking of less than 500 trees, resulting in the protection of timber of perhaps even greater value than in the first example. The real value, however, of these two examples of successful control is far greater than that represented by the money value of the timber protected, since they demonstrate, first, that the most destructive enemy of the pine forests of the central Rocky Mountain region can be controlled at a comparatively slight cost, or even at no expense, whenever the timber can be utilized, and, second, the absolute necessity of expert advice as a guide toward doing the right thing at the right time and at the least expense.

INSECTS DAMAGING DECIDUOUS FRUIT TREES.

An investigation of the pear thrips was begun in the fiscal year, and a field station for this purpose was located near San Jose, Cal. Careful life-history studies were made, and special attention was given to experiments in the field with methods of control. Various sprays were tried, and two of them give promise of efficacy—namely, tobacco extract and distillate emulsion.

Comprehensive investigations of the peach-tree borer and the plum curculio have been carried on at various points and demonstration field work against the codling moth has been under way at various points. Investigations and experimental demonstrations against the grape rootworm in the Erie grape belt have been practically completed, to the satisfaction of the vineyardists and to their great advantage. Studies have been made in connection with the serious outbreak of two species of bark beetles in the peach orchards of Ohio and of the grapevine Phylloxera in California. Further than this, an interesting and important investigation has been carried on relative to insects affecting drying and dried fruits in California, to determine the effect that sulphuring may have in affording protection against insect infestation.

FIELD CROP INSECTS.

The great damage done by the so-called "green bug" in 1907 was the occasion for the beginning of a very extensive investigation to ascertain its life history and possible remedies. During 1908, however, no comparable outbreak occurred. By the end of June, over its entire range, from Texas to the Canadian border, the insect was present in limited numbers and apparently awaiting only favorable weather conditions to become again destructive. These conditions did not recur, and there was therefore no opportunity for large-scale remedial experimentation. A careful study of the insect over the greater part of its range has been made, with the result that facts have been obtained which will prove of practical value another season.

Extensive wheat-sowing experiments have been carried on again in investigations of the Hessian fly. Valuable information has been gained, and the advice of the Department experts has resulted in the

avoidance of much damage in several different localities. Further experiments in the transfer of parasites from one portion of the wheat belt to another have resulted in the complete saving of threatened crops, but a just estimate of the value of these experiments can not be formed until another season.

INSECTS INJURIOUS TO VEGETABLE CROPS.

During the year additional work has been done on the insects affecting truck crops in Texas, Florida, and southern Virginia. The opportunities offered by this localized work in the way of experiments on a large scale in the field have shown that nearly all of these insects can be economically controlled. Insects affecting the sugar-beet industry in the West have been studied in cooperation with the State Agricultural Experiment Station of Utah, and an agent has been located in California to continue these investigations.

INVESTIGATION OF HYDROCYANIC-ACID GAS FUMIGATION IN CALIFORNIA.

This investigation was begun with the fiscal year. A thorough study was made of the existing methods, and this was followed by the institution of large-scale experiments, covering as rapidly as practicable the different features of the problem, in order to discover the best formulæ and mechanical methods and the particular dosage for the different insects involved and for trees at different conditions as to the effects on blooming or the maturity of the fruit. Many interesting problems have been evolved in this investigation, and the results already achieved have been of great value not only to the citrus-fruit growers of California but to all fruit growers who may in the future have occasion to use this process.

INSECTS INJURIOUS TO STORED PRODUCTS.

An important investigation was begun during the fiscal year concerning the insects injurious to stored cereals in the mills of the South, at the request of many milling companies in Kansas, Oklahoma, Missouri, and Texas, and on behalf of the steamship owners and operators of Galveston, Tex., and New Orleans, La. One of the special subjects has been the flour beetles which injure prepared cereals, especially such as are manufactured in Kansas and Missouri and shipped through New Orleans for European ports. The underwriters who insure against this damage claim that flour shipped southward in the warmer months through the warm climate of the Gulf ports is much more liable to damage by these insects, and report that many thousands of sacks of flour shipped by that route to various European ports within the last year were seriously damaged. In the course of this investigation it has been and will continue to be the especial aim to discover the main points of original infestation—whether in the mills, on the railways, on the steamship docks, or on the steamers; and these points once determined, remedial experimental measures will be instituted.

WHITE FLY INVESTIGATIONS.

The investigation of the white fly in Florida has been continued, on an enlarged scale, under increased appropriations provided by Con-

gress. The important work has been carried on at headquarters, at Orlando, Fla. The principal lines to which the investigation has been devoted during the year were, first, the control of the pest by fungous parasites of the white fly, and, second, control by fumigation. Many important and interesting facts have been determined concerning the fungous parasites, and the fumigation experiments have indicated a favorable outlook for the complete success of the process. An improved tent and a new form of dosage table have been devised, and the process has been simplified so that an orange grower, by following simple instructions, can fumigate his trees with the same degree of accuracy as the most experienced expert. Practical demonstrations have been carried on in St. John, Orange, Hillsboro, Manatee, and Lee counties, and great interest has been manifested by the citrus growers throughout the State.

INSECTS WHICH CARRY DISEASE TO MAN AND DOMESTIC ANIMALS.

Presumably owing in part to the very general spread of information contained in circulars issued by the Bureau of Entomology, the country has been aroused during the last fiscal year as never before to the danger of permitting house flies to breed unchecked and to carry filth and disease through communities. Many boards of health have taken up the matter and much work has been done to emphasize the importance of this insect as a disease bearer. During the year an especial effort has been made to learn exact facts relating to the seasonal prevalence of the house fly, with the idea of comparing, at the close of the season, the increase and decrease of the house fly with the increase and decrease of typhoid fever, in the hope of emphasizing the part played by the house fly in the carriage of typhoid. This work has been carried on in the city of Washington, and the results will be announced upon the completion of the computations.

Three investigators have been at work during the fiscal year upon the facts relating to the life history of the cattle tick. As a result of this study it has become possible to lay down an important law regarding time and conditions when cattle may be allowed to run in pastures without becoming infested. This discovery is based upon the fact that the tick eggs do not hatch in the spring until a certain amount of temperature is accumulated. One of the great difficulties in the control of the tick is that many ranchers are overstocked and can not leave part of their holdings of cattle in certain fields for the time requisite to starve out the ticks. This difficulty is minimized as a result of the discovery above mentioned, since it has shown the latest date on which it will be safe for cattle to remain in pastures from which the ticks are to be eradicated or reduced in numbers. During the year internal parasites of two genera of ticks have been found, and experiments are under way in an attempt to cause these parasites to attack the cattle tick.

BEE CULTURE.

The work on bee culture has been enlarged, and its operations have been unusually productive. The work on bee diseases has been continued through the year, and it has been shown that the annual loss from these diseases, conservatively estimated at $2,000,000, may be considerably reduced by the application of better methods of manip-

ulation. Testing of different races of bees has been carried on near Washington, and a study of the production and care of extracted honey, a study of the present status of bee keeping, experiments on mating queens in confinement, and other work looking toward the bettering of apiculture has been under way.

BUREAU OF BIOLOGICAL SURVEY.

The several lines of investigation under way in the Bureau of Biological Survey at the time of presentation of my last report have been continued and new ones have been undertaken.

RELATION OF MAMMALS TO AGRICULTURE.

In their relations to agriculture mammals differ considerably from birds. Few birds are so harmful that their wholesale destruction is called for, since by devouring destructive insects most of them render a full equivalent for any mischief they may commit. Such is by no means true of mammals. A few are very beneficial, and the usefulness of such servants of man as bats, skunks, weasels, badgers, foxes, and moles should be known and appreciated, that their lives may be spared and they be allowed to continue their good work. Unfortunately, a much greater number of our mammals are everywhere injurious, and are the more dangerous because where they do not exist in great numbers their destructive habits often escape particular notice.

As the result of much experimental field work, the destruction of wolves and coyotes by locating the breeding dens and killing the young and by approved methods of poisoning and trapping have been earnestly advocated as the most practicable means of checking the increase of these formidable carnivores. Circulars describing these methods have been widely distributed to stockmen and others throughout the wolf country, with the result that during the past year more wolves and coyotes were destroyed than ever before, the total number of wolves known to have been killed being over 1,800 and the number of coyotes about 24,000. The saving of stock by this means is estimated at not less than $2,000,000.

Although losses by field mice have proved a steady drain on the resources of American farmers and nurserymen, yet only occasionally and over limited areas has the damage been so great as to attract special attention. The extent of the destruction of crops by mice in the United States has never even approached that in Europe, where they have overrun whole provinces, leaving ruin in their wake. During the past year, however, a native species infested the alfalfa fields in Humboldt Valley, Nevada, in such multitudes as to destroy nearly the whole crop. Out of the 20,000 acres of alfalfa in the valley, 15,000 acres were a total loss, so that the fields had to be replowed and reseeded. During the past year the Biological Survey sent two assistants to Nevada for the purpose of conducting experiments and demonstrating to the ranchmen the best methods of destroying the animals. As the result of trials with various poisons, it was found that sulphate of strychnine on chopped green alfalfa, or when that is not procurable, on alfalfa hay, is a most effective poison. Even on ranches where the number of field mice reached

the astonishing total of 12,000 to the acre, relief was obtainable by careful and systematic poisoning at the cost of only 70 cents per acre. By means of the combined efforts of the farmers of the valley, using methods devised by the Survey, the number of mice was finally so greatly reduced that the hawks and owls, gulls, herons, ravens, skunks, badgers, weasels, foxes, and coyotes, which had assembled early in the outbreak and killed at least 45,000 mice a day, were able to take care of the remainder and prevent them from doing serious damage, thus furnishing an important object lesson as to the usefulness of these destroyers of rodents when permitted to do the work they are fitted by nature to perform.

The rat continues to cause great losses throughout the United States. During the past year an attempt was made to ascertain the approximate damage done to property by this rodent in the cities of Washington and Baltimore. Many business men were interviewed, including dealers in various kinds of merchandise, feeders of horses, managers of hotels and restaurants, and manufacturers. The inquiries included all sections of the two cities and both small and large dealers. Data were obtained from some 600 firms and individuals, from which it was estimated that the annual loss from rats in Washington is about $400,000; in Baltimore, upward of $700,000. Assuming, as is probable, that similar conditions obtain in all our cities of over 100,000 inhabitants, the damage by rats in these centers of population entails a direct loss of $20,000,000 annually. This enormous sum gives an idea of the still greater total loss inflicted by this rodent throughout the length and breadth of the land.

The rat continues also to excite grave apprehension because of its agency in distributing the dreaded plague and other diseases. Boards of health and the Marine-Hospital Service in several of our maritime cities have been prosecuting active war against the rodents, and large sums have been expended in efforts to effect their extirpation. No one method has proved adequate, and only by concerted, systematic, and persistent efforts is it possible to reduce and keep down their numbers. The rat-proof construction of buildings, the constant use of traps, and the use of poisons wherever possible will go far toward assuring public safety. Experiments with various poisons and mechanical means of destruction have been made during the year, and a report on the subject with recommendations will soon be issued.

As in previous years, many complaints of damages by rabbits to orchard trees and to various crops have been received. In a previous report the well-known lime and sulphur wash in general use as a remedy against the San José scale was recommended as a protection against rabbits. A number of orchardists have been requested to give this simple and inexpensive remedy a fair trial. It is being experimented with in different sections, and highly satisfactory reports as to its efficiency have been received; hence its use on a larger scale will be urged. If, as has proved to be the case in several instances, a single application of this inexpensive wash will protect orchard trees against the attacks of rodents for a whole winter, the fact can not be too widely advertised.

In the great region west of the Mississippi River ground squirrels are abundant, and in States where grain is extensively cultivated they are exceedingly destructive and annually cause the loss of many

thousands of dollars. In California it has lately been discovered that their presence in a community threatens a danger far greater than any pecuniary loss, however large. Recent investigations conducted by the United States Marine-Hospital Service prove that at least one species of ground squirrel is susceptible of plague, and carries the germ of this dread disease, which, as in the case of rats, is communicated to human beings through the agency of fleas.

A bulletin on the subject, containing directions for destroying the animals and accompanied by a map showing definitely the area infested by the Beechy ground squirrel, is in course of preparation and will be widely distributed among farmers and others, especially in the coast districts, where the danger of the infection of squirrels by plague-stricken rats is greatest.

DEER FARMING.

For the purpose of raising deer for the market their domestication, even their semidomestication, though feasible enough, is not necessary; and one of the greatest advantages of the business is that tracts of unproductive land, when fenced, may be utilized for the purpose, the animals remaining almost in their natural state. It is claimed that there are 250,000,000 acres of land in the United States unfit for general agriculture or for the pasturage of horses, cattle, or sheep, upon which the raising of Angora goats would be profitable. It is thought that a large part of this vast tract, with equal or greater advantage, could be devoted to the growing of venison. The greatest obstacles at present in the way of the successful prosecution of the business of deer farming are State game laws. A Farmers' Bulletin on deer farming has been issued, detailing the results of past experiments, setting forth future possibilities, and explaining the best methods of procedure.

FOX FARMING.

Fox raising has already been undertaken by a number of persons with more or less success, according to the location, amount of capital invested, and experience. As the result of recent investigations in the field, supplemented by correspondence, much information on the subject has been obtained, and a Farmers' Bulletin containing the essential details of the business has been issued and is now being distributed. It is believed that in regions suited to the business fox farming may be undertaken by farmers and others with excellent promise of success and that it will yield satisfactory returns for the investment of the necessary capital, time, and labor.

RELATION OF BIRDS TO FRUIT RAISING.

An accurate knowledge of the relations of birds to the orchard is peculiarly important that the orchardist may know his friends from his enemies, especially since among the birds that seem to be enemies are some whose services in destroying noxious insects more than compensate for the toll they levy on the fruit. Much attention has been paid to this subject in its relation to the west coast, where the industry of fruit raising is each year becoming more and more important, and the stomachs of more than 600 birds, including many of great eco-

nomic value, have been examined and the contents determined. The work has been pushed as rapidly as possible, and the second and final part of a report on the birds of California in relation to fruit raising is now nearly ready for the press.

GAME PROTECTION AND INTRODUCTION.

The present means by which the Biological Survey controls or influences bird and game protection are: (1) By supervising bird and game reservations; (2) by supervising interstate commerce in game; (3) by supervising the importation of wild birds and mammals from foreign countries; (4) by cooperating with officials, organizations, and individuals concerned in the protection of game and birds, and (5) by furnishing information by means of publications and correspondence concerning the preservation of game and birds.

The operations of the year may be briefly summarized as follows:

Nine new bird reservations, making a total of 16, were created by Executive order—located off the coasts of Florida, Louisiana, Oregon, and Washington. Wardens were appointed for the Oregon and Washington reservations, and one for the Florida reservations (five in all). The large colonies of birds that frequent these island reservations will in future be protected and may be confidently expected to increase rapidly.

The usual careful scrutiny of all consignments of wild birds and mammals imported into the United States was maintained throughout the year. Two mongoose—animals specifically prohibited from entry by the act of May 25, 1900—were refused admission at New York in January, and in February a consignment of song thrushes designed for liberation on Coney Island and 200 skylarks to be liberated in California were also denied entry, owing to the danger of these European birds becoming pests in this country, as they have in Australia and New Zealand. Birds and mammals are entered principally at New York. Of 103 consignments inspected 99 arrived at that port. It may be noted that the total cost of inspection, by means of which this large country is guarded against the danger of the introduction of animal pests, is less than $1,000.

The number of birds imported into the country continues to grow, and this year reached a total of about 450,000, consisting, as usual, mainly of canaries. The importation of eggs of game birds for propagation shows a decided falling off, the total number brought in being only 714. Especial interest attaches to the importation of European partridges for stocking covers. The number brought over was 7,783, an increase of more than 100 per cent over the importations of the previous year. This apparent growth in popularity of the partridge of Europe as a game bird for America is readily explained by the decrease of two of our own important game birds—the bobwhite and ruffed grouse—both of which have recently suffered severely from climatic vicissitudes.

DIVISION OF ACCOUNTS AND DISBURSEMENTS.

To carry on the work of the Department of Agriculture during the fiscal year ended June 30, 1908, Congress appropriated the sum of $13,123,040, an increase of $1,940,300 over the preceding year. Of this appropriation $8,537,290 covered the ordinary expenses of the

Department, $3,000,000 the permanent annual expense for meat inspection, $1,152,000 the agricultural experiment stations, and $433,750 the printing and binding done under the Public Printer.

The disbursements of the Department for the fiscal year 1908 amounted to $14,148,329.29, and the greater part of the balance of $668,462.34 will be required for the settlement of outstanding liabilities. The apparent excess of disbursements over the appropriations for this fiscal year is due to unexpended balances, amounting to $1,693,751.63, brought forward from "Administration, etc., Forest Reserves," and other special appropriations.

The amount paid for rent of buildings in the District of Columbia for the several branches of the Department was $65,705.

All accounts for the fiscal year 1906 having been settled, the unexpended balance of appropriations for that year, amounting to $196,619.10, was covered into the Treasury on June 30, 1908. The account for the fiscal year 1907 is still open.

The amount estimated for the fiscal year 1910 in the regular appropriation bill is $14,610,626, which includes $720,000 for agricultural experiment stations. In addition there will be a permanent appropriation of $3,000,000 for meat inspection, a permanent appropriation of $624,000 for additional allotments to agricultural experiment stations under the Adams Act, and $510,000 for printing and binding to be done under the Public Printer, making a grand total of $18,744,626, which is an increase over the fiscal year 1909 of $3,084,520, or 19.7 per cent. Of this increase $2,095,300 is for maintenance and improvements of the National Forests, and the balance, $989,220, is distributed among the other Bureaus and Divisions of the Department.

To sum up the fiscal affairs, it may be added that the principal items of increase each year are for the maintenance and improvement of the National Forests and for carrying into effect the provisions of the food and drugs act. In connection with the expenditures for National Forests, the offset of revenues from the sales of timber and grazing should be taken into consideration. During the fiscal year ended June 30, 1908, these amounted to $1,839,374.92. Since July 1, 1907, these revenues have been deposited in the Treasury to miscellaneous receipts, while prior to that time they were used for the maintenance and improvement of the National Forests, so it will be seen that the National Forests are practically self-supporting.

At the present time the total area of our National Forests is 167,027,319 acres, and the estimated cost of maintenance 2.73 cents per acre, a very small amount when compared with the cost of maintaining forests abroad. France expends annually upon her state forests 95 cents per acre, Switzerland $1.32, Prussia $1.58, and Saxony $2.32. These countries are named because in them the management of the forests is most profitable in products.

DIVISION OF PUBLICATIONS.

During the past fiscal year 1,522 publications were issued, containing 58,510 printed pages. Of these, 477 were new publications, 998 were reprints, and 77 were publications of the Weather Bureau. The total number of copies of all publications printed during the year was 16,875,516. These figures represent but a slight increase

over the corresponding figures for 1907. There was, in fact, an actual decrease of 74—or about 14 per cent—in the number of new publications, the increase being entirely in reprints to meet the demands for copies of publications already issued.

DISTRIBUTION OF FARMERS' BULLETINS.

It is the Department's established policy to make the widest possible free distribution of Farmers' Bulletins, written in simple, popular style and printed in cheap form. During the past year 26 new bulletins were added to the list, bringing the total number in the series up to 327. Of these new bulletins more than three-quarters of a million copies were issued, and the reprints of earlier bulletins, for which there is a strong and steady demand, made the grand total of Farmers' Bulletins issued considerably above 6,000,000 copies. Usually four-fifths of the copies printed are allotted to Senators, Representatives, and Delegates for distribution among their constituents. It has invariably happened that some Members of Congress called for only a part of their quotas, leaving the remainder in the document and folding room of the Department. To prevent the accumulation of these unused residues and at the same time to enable the Secretary to place these bulletins where they would serve their intended purpose, Congress, prior to the year 1907, uniformly provided that these unused residues of Congressional quotas should revert to the Secretary for distribution after a fixed date. Under this provision the Secretary was able each year largely to supplement the insufficient supply of Farmers' Bulletins allotted to him.

SALE OF DEPARTMENT PUBLICATIONS.

The year's records of sales of Department publications by the Superintendent of Documents again demonstrated the great popularity of the reports and bulletins of this Department, and the wisdom of providing for their sale and the use of the proceeds in printing additional copies. During the year the Superintendent of Documents sold 94,626 copies of different publications of this Department and received therefor $14,174. The number of copies sold was nearly three times as great as in 1904, and 23,000 more than in 1907. The sales of this Department's publications also exceeded those of all the other Departments combined by about 33,000 copies.

BUREAU OF STATISTICS.

INTERNATIONAL INSTITUTE OF AGRICULTURE.

The International Institute of Agriculture, established under the patronage and through the efforts of the King of Italy in 1905, will be practically organized in the winter of 1908–9. This institute is sustained by forty-six countries, and the membership of the United States is established by the treaty of January 29, 1908.

Among the purposes of this institute are the collection, study, and publication of statistical, technical, and economic information concerning farming, both vegetable and animal products, the commerce in such products, and the prices prevailing in the various markets; the ascertainment of the wages paid for farm labor; the publication

of information concerning new diseases of vegetables which may appear in any part of the world; the publication of information concerning agricultural cooperation, insurance, and credit; and the submission to the adhering governments of measures for the protection of the common interests of farmers and for the improvement of their condition.

INVESTIGATIONS OF PRODUCTION AND DISTRIBUTION.

The organization of the Bureau of Statistics has undergone a change so far as it relates to the division formerly known as "Foreign Markets," the work of which has become larger in scope. This division is now concerned with Investigations of Production and Distribution. It studies the production of wealth on farms, the distribution of farm products at home and abroad, and the economic conditions pertaining to the agricultural element of the population.

PUBLICATIONS AND LIBRARY.

The branch of the Bureau formerly known as the Miscellaneous Division has also been reorganized, and has been named the Editorial Division and Library. This reorganization was made necessary by a notable increase in the number of publications issued from the Bureau; a constant increase in the number of requests, from all classes of the public, for statistical information; and continuous accessions to the Bureau's library of foreign, Federal, State, and municipal statistical literature.

CROP REPORTS ISSUED ON EARLIER DATES.

The monthly crop reports during the year have been published earlier and nearer the dates to which they relate. The reports as to cotton relate to the 25th of the month, and were formerly published on the 3d of the following month; this year their publication on the 1st or 2d has been secured, and it is believed that the date of publication may hereafter be made not later than the 1st of each month. The reports as to grain and other products relate to the 1st of each month, and have been formerly published on the 10th. This year their publication has been made on the 8th or 9th, and it is expected to secure their publication not later than the 7th or 8th of each month.

CROP REPORTING BOARD.

The plan of intrusting the final preparation of reports to a Crop Reporting Board has been continued, and after three full years of trial it has been demonstrated to be an excellent and satisfactory method. It avoids placing all the strain and responsibility on one man, and secures the benefits of consultation and a consensus of judgment among men who have been on the ground.

SPECIAL INVESTIGATIONS.

During the past year the Bureau began the collection of information concerning farmers' cooperative organizations, of which there are an immense number in this country, embracing more than half of the farmers. This undertaking will require several years.

A compilation of the statistics of agricultural imports of the United States, beginning with 1851, was completed. A similar compilation for agricultural exports was made five years ago, and recently the statistics of the re-exports of agricultural imports, or the so-called "foreign exports," were compiled for the same period of years, so that the statistics of the entire foreign trade in every agricultural community for more than half a century will soon be made available to the public.

An exhaustive statement of the acreage, production, and foreign trade in tobacco of the American colonies and of the United States from the earliest times to the present year was undertaken and nearly accomplished.

An extensive investigation of the production, trade, and supply of wheat in principal countries was commenced. The plan is to give special attention to conditions in countries which export wheat and to the consumption and markets in the principal importing countries.

A compilation of the statistics of imports of farm products into the Netherlands for the years 1904–1906 was prepared. The quantity of durum wheat exported from the United States in the fiscal year 1907 was ascertained from reports received from correspondents at the leading grain markets and seaports. What is substantially the world's production of wool was ascertained with much difficulty for inclusion in the agricultural statistics of the Yearbook of 1907. This is the first publication of this information by the Department.

The Bureau is bringing to completion a plan by which it is hoped to secure statistics of tobacco production by types. The State is the smallest unit or geographical division for which the Bureau at present issues detailed reports comparable with similar reports on other products which have been prepared for a long series of years. By the proposed method there can be secured statistics of the amount of each of the different types of tobacco grown in the States where more than one type of tobacco is grown.

DEPARTMENT LIBRARY.

The Library has been moved into the basement of the east wing of the new Department building, where it is commodiously housed in 18 rooms, originally designed for laboratory uses. It is of interest to note that at the time of moving the Library contained 100,000 books and pamphlets, whereas when it was first established in the old building in 1868 it contained less than 1,000 volumes. It is also matter for congratulation that this collection of books of such great value to the agricultural interests of the country is now stored in a fireproof building. In the work of preparing catalogue and index cards, and in all other usual lines of work, the Library has had a very successful year.

OFFICE OF EXPERIMENT STATIONS.

RELATIONS WITH THE AGRICULTURAL EXPERIMENT STATIONS.

Twenty years have passed since the Office of Experiment Stations was established to act as a general agency for the promotion of the interests of the agricultural experiment stations, which were then being organized on a National basis in accordance with the provisions

of the Hatch Act. Although at the outset that Office had no authority over either the work or the funds of the stations, and even now exercises only a very limited control, it has nevertheless been an important factor in promoting their growth and development.

Its relations with the stations have never been more cordial than they are at present, and its influence never broader nor more potent. The scrutiny which the Office makes of the stations' work as related to their use of Federal funds is now more extended and painstaking than ever before. Since this is made, however, in a helpful spirit, the stations generally recognize that it is calculated to promote their best interests and stimulate them to more thorough work for the benefit of American agriculture.

The stations have developed a vast fund of practical information, much of it resting upon a scientific foundation, and have developed their special methods of work. But the dissemination of this information and its demonstration to the farmer have, to some extent, called for a special corps of workers. The supply of competent men to carry on experiments and investigations has never fully equaled the demand, and hence the pressure for their investigations has fixed distinct limits to the time which they could spend in the extension of their work to the farmer. The demand for assistance of a direct nature and the need of various forms of instruction and demonstration have increased year by year. As a result of this condition there has been a sharper differentiation of duties, and the working staff of the station has been relieved, to a large extent, from other forms of activity. Special workers have been provided to look after the teaching work of the college and to do much of the demonstration work and local experimenting, leaving the investigators more largely to their special duties. This broader organization has increased the efficiency of each branch of the work.

The stations are doing more scientific work and at the same time a large amount of practical work. They are carrying their studies more thoroughly over the State and in this way reaching a larger proportion of the farmers and a larger proportion of their problems. The scientific researches inaugurated by the stations under the Adams Act are already pointing, in many instances, to ultimate practical results of fully as great value as those derived from much of the more superficial work and are laying the foundations of the industry broad and deep.

It has been decisively demonstrated that the granting of Federal aid to the States for the maintenance of the stations gave an immediate and tremendous impulse to the organization of these institutions throughout the country and led to increasing liberality on the part of the States in providing for their equipment and maintenance. The latest statistics of the stations gathered by the Office of Experiment Stations show that though the Federal aid to them was greatly augmented by the passage of the Adams Act, the increase in their local funds kept pace with this, so that now more than half the annual income of the stations is derived from sources within the States.

Four hundred and eighty-four station officers do more or less teaching in the colleges with which the stations are connected. During the year the stations published 459 annual reports, bulletins, and circulars, which were supplied to over 774,000 addresses on the regular mailing lists. A larger number of stations than formerly supple-

mented their regular publications with more or less frequent issues of press bulletins and other special publications, and most of the stations report a large and constantly increasing correspondence with farmers on a wide variety of topics.

THE AGRICULTURAL COLLEGES AND SCHOOLS.

The progress made in agricultural education in the United States during the past eleven years as a result of popular demand stimulated by the work of the State agricultural colleges and experiment stations and of this Department is unprecedented in the history of the world. In 1897, when the present administration of this Department began, all but one of the land-grant colleges were in running order and doing excellent work, but their total income was only $5,000,000; to-day it is almost $15,000,000. The property of these institutions was then valued at $51,000,000; now at $96,000,000. Then there were less than 4,000 students in agricultural courses; now there are over 10,000. Ninety of the 1907 graduates of these courses accepted positions in the agricultural colleges and experiment stations or in this Department at salaries ranging from $500 to $1,700 and averaging $948.66. It is stated by presidents of the agricultural and mechanical colleges that of late the graduates of agricultural courses find remunerative employment much more readily than the graduates from engineering courses.

But the most rapid progress has been made in the field of secondary and elementary education in agriculture. In 1897 Minnesota had the only State agricultural high school and Alabama had just made provision for the last of its nine district agricultural schools. The teaching of agriculture in the public elementary schools was scarcely thought of. To-day there are 15 agricultural high schools of the Minnesota type and 40 other agricultural high schools receiving State aid, 16 privately endowed colleges and high schools giving instruction in agriculture, 115 State and county normal schools preparing young people to teach agriculture, and, on our lists, over 250 public and private high schools and academies giving some instruction in agriculture. There are 16 institutions offering correspondence and reading courses in agriculture and 26 private or special elementary agricultural schools.

In thirteen States the teaching of agriculture in the rural schools is now required by law. It is encouraged by State and county school officers and taught in some of the rural schools of thirty-one other States and Territories. Forty-four States and outlying possessions, then, are making some effort to teach their youth the underlying principles of our greatest productive industry.

This Department is aiding in the promotion of this great movement through all its different Bureaus and Divisions, but the Office of Experiment Stations is giving special attention to it. That Office is cooperating with the Association of American Agricultural Colleges and Experiment Stations, with the National Education Association and other educational associations and their standing committees, and with State and local school officers in the different States and Territories in preparing suggestive courses of study in agriculture, horticulture, and other related subjects, in developing suitable laboratory material and exercises for schools of different grade, and in

securing suitable literature to supplement the agricultural text-books and manuals used in the colleges and schools. Many of the publications of this Department are used in this way.

Congress has granted a small additional appropriation for the work of the Office of Experiment Stations in relation to agricultural colleges and schools, which will enable the Office to increase the effectiveness of its organization to some extent, but not in proportion to the rapidly increasing demands made upon it by educational institutions throughout the country. It will not be possible to branch out along new lines, but it is hoped that with the aid and cooperation of other Bureaus of the Department, a beginning may be made in the preparation of two new classes of publications now much needed for the assistance of teachers and pupils in public schools: (1) Instructional publications or brief monographs giving reliable and up-to-date methods of performing certain agricultural operations, such as How to restore humus to the soil, How to prevent soil erosion, How to manage the wood lot, How to get a good stand of corn, How to make and apply Bordeaux mixture, etc., and (2) informational publications, brief monographs concerning the origin, distribution, and importance of leading agricultural crops, and the supply, distribution, and importance of our National agricultural resources. Publications of the first class are needed mainly by the schools in which agriculture is taught, but those of the second class, informational publications, are in demand from all classes of schools, city and rural, to supplement the text-books of geography, botany, zoology, and agriculture.

FARMERS' INSTITUTES.

The farmers' institute has developed until it has become a leading agency in the dissemination of agricultural information. Over 2,000,000 people are reported as having attended the regular institute meetings during the year and 164,000 the special institutes, while there was furnished by State and local authorities $318,000 for carrying on the work. The appropriations represent an increase of $44,000 and the attendance an increase of 415,000 over the previous year.

INSULAR STATIONS.

The efforts of the Alaska, Hawaii, and Porto Rico stations along the lines of diversified agriculture have been continued. The Alaska stations devote their principal efforts to live stock, horticultural crops, and cereal growing. The cattle formerly at the Kenai station have been removed to Kodiak and the two herds combined. The station now has about 60 head of registered Galloway cattle, which have demonstrated their ability to withstand winter conditions by going through the last winter without any shelter except an open feeding shed. A larger range is needed for the animal-breeding station, and a survey has been made of a suitable tract. The horticultural investigations at Sitka are quite promising. In the young orchard some of the trees have shown their first blooms, and a few varieties of cherries bore fruit this year. The plant-breeding work is being continued, and as but few varieties of apples have so far shown any indication of surviving Alaskan winters, experiments are being conducted in pollinating some of the most promising varieties with pollen from the native crab apple, and seedlings will be produced as fast as possible.

During the past season some of the crosses between the wild and cultivated strawberry and the hybrids between the salmon berry and the cultivated raspberry bore fruit, and selection experiments will be conducted for the establishment of any desirable varieties. A species of willow which is well adapted to basketry has been introduced by the station and was found to grow exceedingly well. The cereal investigations are carried on principally at Rampart and Copper Center, where selections of the earliest ripening heads of every variety are being made. A severe frost again destroyed the grain crop at Copper Center, but at Rampart all varieties yielded well, as has been the case nearly every year since the establishment of the station in 1900. Work was actually begun in developing a station near Fairbanks, reserved for that purpose by executive order, March 22, 1906. About 10 acres were planted to oats and potatoes and arrangements made for clearing more land and for the erection of much-needed buildings. At the Copper Center station plant breeding with native grasses and leguminous plants has been begun, and about 90 species have been brought together for further study.

The Hawaii station continues its work in the diversification of agriculture in those islands. The experiments in shipping tropical fruits have been continued, and it has been demonstrated that pineapples, avocados, and similar fruits may be successfully shipped to any point within thirty days' direct communication with Honolulu. The rice investigations have been continued and extended, and the value of sulphate of ammonia and other high-grade fertilizers when applied to rice has been shown. The results of these experiments have already become well known, and dealers in fertilizers report a marked increase in the sales of high-grade fertilizers to rice growers. The studies in Hawaiian honey made by the entomologist have resulted in the adoption of suggestions whereby a largely increased revenue is obtained by bee keepers. A study has been begun of the insects affecting live stock and suggestions made for the control of some of the more troublesome ones. Among the more promising of the newly developed agricultural industries of Hawaii is pineapple growing, and the study of the soil and fertilizer requirements of this crop has been begun on a comprehensive scale. All the departments of the station will give attention to the problems connected with the cultivation and marketing of this fruit. The introduction of Chinese and Japanese matting rushes has been successfully made and the profitableness of growing these seems to be well established. An experiment in harvesting salt-marsh rice for hay has indicated that large quantities of such hay can be produced in Hawaii to take the place of the hay which is imported, to the amount of $350,000 worth annually, most of it coming from California. The experiments in tapping rubber trees have been continued, and, as showing the possibilities of rubber production, two Ceara rubber trees which had been tapped in July, 1907, when tapped again in January, 1908, yielded 6½ ounces of dry rubber in nine days. When it is considered that more than 600,000 rubber trees, 90 per cent of which are Ceara rubber, have been planted in Hawaii within the past three years, the importance of experiments in tapping and with coagulants for rubber latex may be appreciated.

The work in Porto Rico consists of experiments in plant and animal introduction and breeding, crop production, control of insect and

fungus pests, reforestation, etc. Seedling pineapples and seedling sugar canes, some of which were originated at the station, and improved varieties of other important crops are under observation at the station. Experiments in breeding pigs and poultry have proved quite successful at the station and the surplus is sold to planters at fair prices. No difficulties have been met with in raising any of the improved strains and the demand is always in excess of the station's supply. Experiments in ensiling cane tops for feeding to cattle have indicated the practicability of using this extensive source of forage, most of which is now wasted. Experiments on the reforestation of denuded hilltops are being continued and some varieties of eucalyptus have been found that are well adapted to this purpose. Some of the introduced varieties of coffee are beginning to bear and it is now possible to pass judgment on their qualities. The common Porto Rican coffee has not met with a favorable reception in the continental portions of the United States, and it is believed to be a good policy to introduce the types of coffee which are demanded by the trade. The highly flavored Java coffees seem to retain their well-known characteristics when grown under Porto Rican conditions and coffee planters are taking a deep interest in this experiment and are planting the improved varieties as fast as seedlings can be supplied. The station's suggestions regarding planting, cultivation, pruning, etc., are being quite generally followed on the new plantations. The entomologist has been studying the life history of a number of troublesome insects and has worked out methods for the control of some of them. Parasites of the eggs of the tobacco hornworm, mentioned in the previous report, have been distributed in Porto Rico and also in sections of the mainland. A system of cooperative demonstration experiments has been successfully inaugurated which has proved very popular as a means for the dissemination of information relating to a more rational system of agricultural practice.

Preliminary steps have been taken for the establishment and maintenance of an experiment station in the island of Guam, and the conditions in that island are believed to be favorable for the restoration of agriculture and its development along more modern lines.

NUTRITION INVESTIGATIONS.

According to authority granted by Congress the reconstruction of the respiration calorimeter is proceeding, and reports on investigations made previously are being prepared for publication.

It is expected to take advantage of new features suggested by the work of others or devised by our experts to simplify and improve the respiration calorimeter in several important ways. The work is being rapidly pushed and the apparatus will be ready for use before the end of the fiscal year.

With the aid of the respiration calorimeter it is proposed to study the relative ease of digestion of cheese made and cured in different ways, a line of work of the utmost importance in view of the experiments already completed, which have demonstrated the thoroughness of digestion and high nutritive value of cheese as an economical article of diet. It is also proposed to study with the respiration calorimeter the relative value of butter, lard, beef fat, olive oil, and

other edible and culinary fats as sources of energy in the body, a matter on which data are much needed in considering problems now before the Department, and to make similar studies needed to round out the Department's work on the food value of cereal products and meat and meat products.

IRRIGATION INVESTIGATIONS.

As in the past year, the most pressing needs of the arid regions are practical information for settlers on the large areas now being brought under ditch, and the checking of losses of water in its transportation to the place of use and in its application to fields. In view of this fact work has been concentrated on these two lines. Never before in our history has there been so great activity in the construction of canals and reservoirs to provide a water supply for our arid lands. The construction of these works is under the direction of trained engineers, while the preparation of the land to receive water, which in many cases involves an expense fully as great as for the works which supply the water, is left to the settlers who come almost entirely from sections where irrigation is not practiced and are consequently ignorant of irrigation practice. Realizing that the proper use of water is fully as important as the proper construction of works, we have made a special effort to make available for settlers in the arid region the same degree of expert knowledge regarding the performance of all the operations connected with irrigation that has been used in the construction of irrigation works. This is being accomplished by studying the practice of the older irrigated sections to get the benefits of their experience, and by experiments to get a more exact knowledge of the action of water in the soil and the effect of different methods of applying water and cultivating the soil. To make the results of this work available as soon as possible, many special agents have been employed to assist our regular force of experts. It is estimated that there is now under ditch and awaiting settlement fully 5,000,000 acres. To cultivate these lands will require 100,000 settlers. It is also estimated that each settler must invest at least $1,500 in cash in addition to his labor in establishing himself on a new irrigated farm, calling for an expenditure of $150,000,000, a very large part of which will be wasted if settlers are not given expert advice.

The magnitude of the losses of water in irrigation practice and the importance of checking these losses have been repeatedly mentioned in former reports. Careful observations indicate that not to exceed one-third of the water diverted from streams or stored in reservoirs is actually used by crops in the processes of growth. As the area which can be irrigated is limited by the water supply, not by the extent of available land, any preventable loss is an unnecessary restriction of the irrigated area. Some loss is unavoidable, some can be prevented only at great expense, but much can be done by a better adaptation of methods to the conditions of soil and subsoil without any noticeable increase in present cost. In no other way can so great an additional area be supplied with water at so small an expense. This saving, however, requires an accurate knowledge of the action of water on the soils of different types, and to secure this we are carrying on both tank and field experiments throughout the arid region.

Settlement of the semiarid region by those who expect to engage in dry farming has continued with little check, but the experience of these settlers has increased the demand for information regarding the possibilities of developing small water supplies for the irrigation of limited areas in connection with the farming of large areas without irrigation. The farms established for securing such information and for demonstrating the methods of use and the advantages of irrigation have been maintained during the past year and should be continued. The water for the dry farms on the plains must be pumped from underground sources or stored from storm waters.

DRAINAGE INVESTIGATIONS.

Recent estimates made by the Department place the total area of unreclaimed wet lands in round numbers at 79,000,000 acres. With reference to their productive value as affected by their natural wet condition, these vast areas may be classified as follows:

(1) Lands which are permanently wet and are never fit for cultivation even during the most favorable years.

(2) Lands which afford pasturage for live stock, though the forage which they produce may be of indifferent quality.

(3) Lands which in their natural condition are subject to periodical overflow by streams, but which at other times produce valuable crops.

(4) Lands which yield profitable crops during seasons of light or medium rainfall, but which are wholly unproductive in seasons characterized by greater than the normal rainfall.

It is estimated that of the first class there are 52,000,000 acres; of the second class, 7,000,000 acres; of the third class, 15,000,000 acres, and of the fourth class, 5,000,000 acres. In addition to this area it is estimated that there are 150,000,000 acres of occupied farm land whose production would be increased 20 per cent, without additional labor in management or cultivation, were it judiciously drained.

The existence of these conditions suggest that immense agricultural possibilities lie before us in the reclamation of the so-called swamp lands, and also in the better drainage of lands which are now under cultivation. That marked attention is being given to this subject by landowners is evinced by the large number of inquiries received by the Department upon matters directly related to agricultural drainage.

OFFICE OF PUBLIC ROADS.

RELATION OF ROADS TO AGRICULTURE.

For many years the Department has endeavored to impress upon producers and consumers the close and intimate relationship of the public road to agriculture, and while endeavoring by practical demonstration and scientific experiment to improve methods of construction and maintenance, has lost no opportunity of awakening the public to a proper appreciation of the great economic importance of road improvement and the necessity for reform in the management of the public roads. Some conception may be had of the immensity of the task by considering the fact that there are 2,151,000 miles of road in the United States, a sufficient length to encircle the globe at the equator with 86 parallel roads. The total expenditure upon roads for

1904 was nearly $80,000,000. At that time about 38,600 miles had been surfaced with stone, 108,200 with gravel, and 6,800 with special materials, making the whole mileage of improved roads only 7.14 per cent of the total. An effort has been made by the engineers of this Department to estimate the mileage of improved roads in 1908, and the total value of all roads, including bridges and rights of way. Taking the 1904 figures as a basis, and assuming that the macadam roads have increased 12.5 per cent, the gravel 15 per cent, and those surfaced with special materials 25 per cent, we have 43,450 miles of macadam, 124,468 of gravel, and 8,512 surfaced with special materials. The cost of the macadam has been estimated at $4,500 per mile, of the gravel at $1,500, and of other surfacing materials at $1,000.

There are about 1,975,000 miles of earth road, which it is estimated have cost for grading, culverts, bridges, and all other items of expense an average of $500 per mile. The right of way, which has been estimated at 40 feet in width for the entire mileage, is worth at the average acreage valuation as given in census reports $342,000,000, making a total estimated cost of $1,720,339,000 for all the roads of this country. Over these roads at least 250,000,000 tons of freight are hauled every year to railroads, not including the immense tonnage hauled to wharves and docks for water shipment, which we are unable to estimate. The data collected by the Department indicate that this hauling is done at an average cost of not less than 23 cents per ton per mile, and that the average haul is about 9 miles, which goes to show that the transportation over the public roads to the railroads represents an annual cost of over half a billion dollars. Hauling in France is done in many cases at as low a cost as 7 cents per ton per mile, and the average there is probably not more than half of the average for the United States. The selling price of farm products is largely determined by factors beyond the control of the farmer. His prosperity must be measured by the margin of profit above the cost of production and of transportation; and it is only when the great agricultural population awakens to a realization that the road problem is a farm problem that we can look for substantial progress in this important branch of transportation.

HIGHWAY ENGINEERING.

The Department has for several years successfully carried out a plan of appointing each year a small number of graduates in civil engineering and giving them thorough and practical training in highway work for a period of one year. This is not gratuitous instruction on the part of the Government, as the young men, while receiving a small salary and valuable instruction, are, on the other hand, rendering service to the Government. At the end of one year these students may be retained in the service without further examination and promoted to the position of assistant engineer. The plan has worked out exceedingly well, and a number of young engineers have passed from the Government service to important positions in State and county road work.

SAND-CLAY ROADS.

In many sections of country, almost entirely without road-building rocks, the cost of macadam roads is prohibitive. Sparse population

and lack of funds prevent the building of hard roads in many cases. To meet the needs of such localities, the Department has by research and experiment endeavored to devise methods of construction which would utilize to the best advantage the materials immediately available. For many years the sand-clay method has been in successful operation in various Southern States, and the Department has endeavored to bring it more and more into general use. The past summer witnessed the beginning of experiments with the sand-clay method at Englewood, Kans., and later in the summer at Dodge City, Kans. The people at these Kansas points are enthusiastic over the possibilities of the sand-clay road, and at this stage of the work the indications are that the experiment will prove as successful on the Great Plains as in the South. If our hopes are realized in this work, a tremendous benefit will result not only to Kansas, but to many of the trans-Mississippi States.

BURNT-CLAY ROADS.

For several years the Department has been conducting experiments with burnt clay in the Mississippi Delta region. While the experiments have not been uniformly successful, the Department feels justified in announcing that burnt-clay roads are entirely feasible, and under favorable conditions are almost as satisfactory as macadam. A burnt-clay road completed by the Office of Public Roads of this Department at Greenville, Miss., on November 4, 1907, withstood the trying climatic conditions of the winter and spring and an exceedingly heavy traffic, and showed very few signs of damage at the close of the past summer. Another burnt-clay road at Tallulah, La., constructed during the past summer, is now in excellent condition. The burnt-clay road will generally be constructed in sections of country where macadam materials are not available, and in such cases the cost will probably not exceed on the average one-third the cost of the macadam.

DUST PREVENTION.

The destructive effects of automobile traffic on macadam roads have occasioned much uneasiness, as many million dollars have been expended in this form of construction. The engineers of the Department have, in common with others in this country and in France and England, conducted numerous experiments with a view to determining the exact cause of the deterioration of macadam roads and to devising methods of treatment or construction which would effectually meet existing conditions. The materials used in the experiments by the Department have included, among others, tar preparations, asphalt oils, temporary expedients, such as calcium chloride, and several special preparations originated by the Office of Public Roads of this Department. Some measure of success has attended the work thus far, and it is hoped that much progress will be made within the next few years.

OBJECT-LESSON ROADS.

Measured by comparison with previous years' results, the object-lesson work of the past year was the most successful in the history of the Department. At the close of the year 31 object-lesson and experimental roads had been completed, or were in course of construction, illustrating the best methods of road construction as adapted to

conditions in each section of the United States. These object-lesson roads were instrumental in the giving of instruction in the art of road building, and it may therefore be said without exaggeration that the Department maintained 31 temporary schools in road building.

The engineers from the office made the necessary surveys and prepared the plans and estimates and supervised the construction, instructing the local road builders at each stage of the work. In all, 10 macadam, 6 sand-clay, 4 gravel, 3 earth, 3 burnt-clay, 1 shell, 2 tarred, and 2 oiled roads were constructed, making a total of 223,208 square yards of road surfaced. Object-lesson and experimental roads were constructed in Massachusetts, Virginia, West Virginia, South Carolina, Kentucky, Tennessee, Georgia, Florida, Alabama, Mississippi, Louisiana, Texas. Wisconsin, Missouri, Arkansas, North Dakota, Nebraska, and California during the year.

UTILIZATION OF BY-PRODUCTS.

Approximately 20,000,000 tons of blast-furnace slag are produced annually in the United States, most of which is a total waste. Slag has been used very slightly as a road-building material, for the reason that it is exceedingly difficult to maintain a well-bonded surface. The Office has, during the past year, inaugurated experiments in the building of roads of slag in combination with tar and asphalt preparations along original lines. It is hoped that these experiments will not only open the way for a more general use of slag as a road material, but that the addition of bituminous binders will result in much progress in the development of dustless roads.

CORROSION OF IRON AND STEEL.

This investigation was begun for the purpose of determining the cause of corrosion of metal road culverts, and to discover if possible the means of preventing or minimizing the corrosion. Investigation thus far has produced data of great scientific and practical value, which are set forth in publications issued by this Department. The results of the work have already proved of great benefit, as several of the rolling mills have materially modified their methods of manufacture to conform to the conditions indicated as essential in the results of the investigations.

During the past summer test fences were erected at Pittsburg and Atlantic City, and at the latter place a number of large plates of steel were set up in frames facing the ocean. These plates were painted with standard pigments and with pigments prepared according to specifications drawn up in the Office of Public Roads. The purpose of this test is to determine the relative merit of the pigments used in the prevention of rust.

REVIEW OF TWELVE YEARS.

In presenting an account of the work of the Department it may be worth while to survey the last twelve years of endeavors, and of their fruition and promise, to which not only this Department has contributed, but also the experiment stations, the agricultural schools and colleges, the State boards and commissioners, the agricultural press, and the farmers themselves in their individual and collective efforts.

Momentous changes have occurred to agriculture in this country during the last dozen years. Features of great import have been introduced. Forces have become operative whose results are already enormous, with the certainty of cumulative and accelerated future consequences for the Nation's good and well-being. The farmer's work and harvest have had the benefit of more varied knowledge and more effective intelligence. His life and living have undergone transformations which increasingly make the farm preferable to the town.

IMPROVED FINANCIAL CONDITIONS.

This period has developed an amazing and unexampled prosperity for the farmer. His improving financial condition has been both an effect and a cause—an effect partly of his own efforts joined to those of public agencies, and also the means of making his life and the lives of his wife and children better worth living.

More wealth has been invested in improving the farm home and in the current expense of farm life. With better houses filled with modern conveniences, the family life has developed in strength and in enjoyable living. Through the introduction of machinery, the betterment of buildings and appliances, and the improvement of methods the farmer's labor is rapidly becoming less in physical stress, and the burdens of the household are becoming lighter. Child life on the farm is entering upon a realm of favoring conditions in the home, at school, and in farming, and home-making apprenticeship is rising to a higher level.

CHANGE FROM LOW TO PROFITABLE PRICES.

The year 1897 or thereabouts marked the farmer's financial turning point. The prices of his products had previously often been below the cost of production, and he occupied a weak position as a seller. Within a very few years thereafter prices had risen so as to make him strong as a seller and to enable him to hold his crops for fair prices.

Corn was worth but 21.5 cents a bushel at the farm December 1, 1896, as an average for the United States, and less than that in the great corn States. By 1900 the price had risen to 35.7 cents, and the November price of this year is 63.5 cents.

Wheat sold for as little as the average of 49.1 cents a bushel December 1, 1894; a marked increase to 69.5 cents favored the crop of 1903, and now the November price is 91.5 cents.

The farmers and planters of the cotton States were in a wretched financial condition when the cotton crop of 1894 was sold for 4.6 cents a pound. Their independence began with the price of 11.66 cents in 1903. During the last six years the mean price of cotton to the growers has been 9.865 cents and the seed has brought them many millions of dollars annually.

Hay was worth at the farm only $6 a ton in 1898; the price rose to $10.01 in 1901, to $11.68 in 1907, and it was $9.22 on November 1 of this year. The farm price of oats was at the low figure of 18.7 cents a bushel in 1896; in 1901 it was 39.9 cents; in November, this year, 46.5 cents. Barley was sold for 32.3 cents in 1896, 45.9 cents in 1902, 66.6 cents in 1907, and 53.7 cents in November, 1908. Rye was at the

low price of 40.9 cents a bushel in 1896; in 1901 the price was 55.7 cents; in November, 1908, 73.7 cents.

Tobacco was not worth raising at the average price of 6 cents a pound in 1896; there was some improvement with 8.1 cents in 1904; still more with 10.9 cents in 1907; and perhaps a higher price this year. In 1896 potatoes brought 26.6 cents a bushel to the farmer; the rise was to 76.7 cents in 1901 and to 69.2 cents in November, 1908.

In the meantime the prices of domestic animals had participated in the forward movement. Horses of all ages had the average value of only $31.51 at the farm January 1, 1897. The average was $52.86 in 1901 and $93.41 in 1908. From the low price of $41.66 per mule in 1897, all ages included, the figure rose to $63.97 in 1901 and to $107.76 in 1908.

The farm price of dairy cows has gone from $21.40 in 1892 to $27.45 in 1898, and to $30.67 in 1908; of all other cattle of all ages, from $14.06 in 1895 to $20.92 in 1898, and to $16.89 in 1908.

A remarkable change in price was in that of sheep, from $1.58 in 1895, all ages included, to $2.46 in 1898 and $3.88 in 1908. Hogs had the low price of $4.10 per head January 1, 1897; the average was $5 in 1900, $7.62 in 1907, and $6.05 in 1908.

The consequences of such rises of prices need not be itemized. The old cotton plantation that no lender wanted as a mortgage security is now sought for investment and its owner can borrow without mortgaging. The farmers of the mortgage-ridden Kansas of former days have stuffed the banks of that State full of money, have organized banks of their own, and have sent money to the East to invest.

AGRICULTURAL SCIENCE.

Relieved of the weight of debt and of suffering under unprofitable prices, the farmer felt more responsive than before to the help offered by the Department of Agriculture, the experiment stations, and other sources during the period under review. Thousands of learned investigators worked for him. Thousands more talked to him repeatedly. Thousands of demonstrations taught how to do by doing. Many boys were educated in agriculture. Hundreds of millions of copies of publications were sent broadcast. The story of what was done by Nation, State, and private persons can here be stated only briefly.

PLANT AND ANIMAL BREEDING.

Both the science of breeding plants and animals and practical methods have made remarkable advance. During the past dozen years breeding has passed the unorganized stage and has come under the domain of science. Rapid advances are being made in the study of the laws under which heredity operates. The exceedingly great value of the rare mutating plant or animal which has the power to project its unusual individual values into its progeny and thus produce a valuable new strain has come to be appreciated as the most important source of creative breeding.

The breeding of types of Sea Island cotton immune to various diseases; the securing of types of nitrogen-gathering plants to use in rotation with such kinds of cotton; improvements of the fiber of other kinds of cotton and of its productivity; the marked increase in corn

production due to knowledge of the laws governing corn breeding; the establishment of important tobacco industries, such as the growing of the Sumatra wrapper leaf and the Cuban filler through adaptation to proper conditions, and the creation of desired strains by breeding; the securing of a whole series of hardy citrus fruits; improvements in wheat and oats—these are some of the grand achievements of plant breeders.

Hybridization and seed selection in the case of existing crops have been performed scientifically to produce varieties to meet new conditions, to produce larger yields, to resist cold, drought, and disease. With the advent of the cotton boll weevil, the breeding of cottons fitted to escape weevil injury, to produce longer staple and heavier yields, and to resist wilt, root rot, and other diseases, was undertaken with gratifying results. Several entirely new cotton hybrids have been developed which possess great improvement over former varieties. This Department's newly bred, heavy-yielding, long-staple Upland cotton, the Columbia, received a gold medal at the Jamestown Exposition.

Corn-breeding methods have developed varieties whose yield is 15 to 25 per cent above that secured by the best of the former varieties. This Department has introduced from Guatemala for breeding purposes new types of corn adapted for growth in the moist Gulf regions and other varieties for growth in the hot arid regions. The development of quick-maturing, high-yielding dent corn for the northern edge of the corn belt has been accomplished by the experts of the Department.

Seed-corn breeders' associations now exist in most of the States of the corn belt. Seed corn is now largely grown as a special crop. Pure strains are being developed, new varieties originated, and older ones improved.

Good progress has been made in breeding single-germ seed balls, which will greatly reduce the labor and cost of growing sugar beets. High-grade sugar-beet seed, fully equal to the best imported, has been bred in this country.

Among the results of breeding tobacco for quality, uniformity, and yield are the Uncle Sam Sumatra, the Hazlewood Cuban, the Brewer Hybrid, and several other improved types which have been disseminated and which give an increased yield of 50 to 75 per cent of great uniformity and high quality.

The Florida sweet orange has been hybridized with the cold-resistant trifoliate orange and several new strains with greatly increased hardiness have been developed, so that the orange-producing area has been much enlarged. From these hybrids it is expected that citrus fruits of great value will eventually be grown throughout the Southern States.

At the Colorado Experiment Station a cantaloupe has been bred that is resistant to the rust fungus. In South Dakota the third generation of seedlings of the native sand cherry produce fruits 1 inch in diameter and of good quality. Native Dakota plums and sand cherries have been hybridized with other stone fruits from Europe and Asia to combine the hardiness of the native fruits with the size and quality, to some extent at least, of the choice cultivated fruits from abroad. In New Jersey practically all of the important

vegetables have been subjected to hybridizing and breeding, and many new varieties with desirable qualities have been produced and disseminated.

Good varieties of wheat have been originated by breeding. The Minnesota station originated numerous varieties, two of which have spread over half a million acres, and yield from 1 to 3 bushels more per acre than the varieties formerly grown. The Maryland and Michigan stations bred new varieties of wheat, which are now grown in those States. The winter-wheat belt has been extended farther and farther north by sowing adapted varieties until it is now grown in regions which had before been regarded as incapable of growing it. Winter character has been added to the spring wheats of the Pacific coast and new hybrids of these wheats are now grown there.

Methods of growing winter oats successfully in Southern States have been developed of late by some of the southern experiment stations and varieties of oats adapted to winter culture have been distributed. The Wisconsin station improved the Swedish Select oats and 5,000,000 bushels of this variety are now grown by Wisconsin farmers.

The Minnesota station originated and disseminated a promising variety of flax for seed production, and the North Dakota station achieved great success in combating the wilt disease of flax by treating the seed and by developing resistant strains.

The Department has begun experiments to ascertain the effects of close breeding. Cooperation of the Department with State stations and farmers has begun to create new strains of farm animals—carriage horses, in Colorado; cattle for beef production under southern conditions, in Alabama; the cross of the horse and the zebra, in Maryland; the reestablishment of the Morgan breed of horses, in Vermont; sheep especially suited to range conditions, in Wyoming; a breed of milking Shorthorn cattle, in Minnesota; draft horses, in Iowa; improved Holstein cattle, in North Dakota; a breed of hens for high egg production, in Maine.

INTRODUCTIONS.

Trained explorers are constantly traversing foreign and remote lands in search of promising seeds and plants for trial and possible introduction into the United States, and from this one feature of the Department's work many millions of dollars are added yearly to our national production of wealth.

From Russia and Africa durum wheat was brought during 1899 to 1902, and thus was laid the foundation of the great crop of this special kind of wheat in this country, which amounted to 45,000,000 bushels in 1907, worth $30,000,000 to the farmers, and providing exports of 22,000,000 bushels. The rice growers of the Gulf coast received superior varieties from the Orient, which have greatly increased the value of the American rice crop and given to it a firmer basis.

Sugar-beet growing for producing sugar had hardly become established in 1897, and the production of that year was only 45,246 short tons of sugar. Since that time this crop has been introduced into new parts of the sugar-beet belt, with the result that the crop of this year amounts to nearly 500,000 tons of sugar, worth $45,000,000.

So immense has become the production of alfalfa, an introduced plant, that attempts to estimate its quantity and value fail. It is supposed that this year's alfalfa hay is worth $100,000,000. This is the great forage plant and soil renovator of a vast area in the Rocky Mountain and Pacific coast regions. Its growth is extending eastward, and it has become generally established as far east as the longitude of eastern Kansas, and it is partly or fully established in spots throughout the North Central States, in the limestone regions of Kentucky and Tennessee, and in a less degree in the North Atlantic State. Several cold and drought resistant strains of alfalfa have been introduced, including an oasis alfalfa from the Sahara, resistant to alkali; various types of Turkestan alfalfa, resistant to drought; Siberian alfalfa, resistant to cold; the sand lucern, a north European variety, very resistant to cold; Arabian alfalfa, resistant to drought; Peruvian and Chilean alfalfas, suitable for culture in the Southwest.

The Swedish Select, the Tobsk, and the Sixty-day oats have been introduced and have proved of far greater value than former local varieties in the North and Northwest.

A variety of soy bean has been introduced from central China, suitable for becoming a cover crop for rice lands and greatly needed by the rice growers of the Southern States.

The best varieties of the date palm, the offspring of the oasis of the Algerian Sahara, have been introduced and established in the Southwest. The dry-land olive has been successfully introduced into Arizona and southern California.

The basic thought underlying plant introduction has been home production in place of importations, the production of wealth and the diversification of products within the Nation in place of dependence upon foreign agriculture.

FARM MANAGEMENT.

The State experiment stations, the colleges of agriculture, and the Department are placing the subject of managing the farm on a scientific engineering basis. The planning of a new farm or recasting the field plan of the old farm are being reduced to such form that they are profitably taught in agricultural schools. A number of the experiment stations have determined the kinds of crop rotations which yield the largest net returns for given soils and agricultural districts. Numerous long-time experiments on State and branch experiment station farms controlled by the Department are under way to determine those crop rotations and other methods of internal management of the farm which will be most profitable and best adapted to the family and other available labor.

In cooperation with the Minnesota Experiment Station a method has been developed of securing under average actual farm conditions the cost of each farm operation and of each crop, animal, or other product. By using these figures of cost per acre and per unit of product, and of the crop or other resulting product, a system of simplified farm accounting and cost keeping has been devised. The most novel part of this system of teaching farm management is farm maps, which serve in such a simple and convenient manner as an annual ledger of crop production cost and net income that farmers can easily use it.

Extensive studies are made of the best practices of successful farmers in all parts of the country. Demonstration of the wisdom of doing things in prescribed ways by calling attention to desirable results; plans of farm management that raise the income per acre from a paltry sum to a very profitable one; instruction in farm practices in hundreds of particulars, the success of which is readily understood in terms of profitable income—these are lines of work which have been followed and have produced widespread diffusion of agricultural knowledge and improvement.

The boll-weevil territory affords a notable example. In 1904 the Department inaugurated on a small scale what is now known as its "Farmers' Cooperative Demonstration Work." The initial efforts met with such emphatic success that the work has been gradually increased until now the whole cotton belt and many outlying regions are covered by a large force of trained field agents, all practical farmers. These men are wielding a wonderful influence among the farmers of the South to adopt better cultural methods, to use improved seed, and thus to increase their profits.

Closely related to this work are the farm management investigations of the Department, consisting primarily of a detailed study of the practices followed on the most successful farms in well-defined communities, and the application or adaptation of these practices to other and less prosperous farms throughout the country. The aim in all this work is to bring the farm up to its maximum producing power through systematic management, both as to cultural practices and as to business methods.

A practice highly important to the corn crop, that of shallow cultivation, has become prevalent in the corn belt and is growing in favor elsewhere; this counts for increased yield. In wheat culture, early plowing and thorough preparation of the seed bed are much more extensively practiced than formerly.

Dry farming has come to be recognized as an important factor in our future agricultural progress. Much useful information has been accumulated to determine the conditions under which crops may be successfully grown, the best systems of crop rotation, and the tillage required for the conservation of soil moisture to adapt new crops to the dry regions. It seems probable that as a part of this work and of the reclamation projects, a half billion acres of dry and arid land will be made available for agriculture in the course of time. The last ten years have witnessed a remarkable exodus of people from the eastern parts of the country to the western, especially to the dry part of the Great Plains. This vast region, formerly considered of little use for cultivation, is rapidly becoming one of considerable agricultural importance under the guidance of the Department and State experiment stations.

SOILS AND THEIR TREATMENT.

Soil surveying was begun by this Department nine years ago. The reason for this work is the fact that each variety or strain of crop produces its best in some certain soil and climate, and that for each soil and climatic condition there are crop rotation and farm-management schemes which pay best. The object of the survey, therefore, has been to find the proper soil for the crop, the proper crop for the

soil, and to aid in devising scientific engineering plans for the management of farms on each class of soil and in each agricultural region. The survey has now covered 150,000 square miles in all parts of the United States, a larger area than the total land area of Great Britain and Ireland, or of Japan. It has led to the growing of special types of tobacco in the Gulf States, it has made marked progress in the standardization of soil descriptions, and it has brought close cooperation between the National Government and various States.

In the course of this survey the alkali problem has been solved. The rise of alkali to the surface had caused the abandonment of wide areas of land in the belief that when once it has appeared no further use can be made of such lands. The Department has demonstrated in widely separated districts in the arid West that the reclamation of areas unproductive on account of the presence of alkali is both feasible and economical.

Much attention has been given to the study of soil bacteriology, and improved strains of nitrogen-fixing bacteria have been developed and widely disseminated and have proved highly useful in the inoculation of the various leguminous crops to increase their accumulation of nitrogen.

Instruction in the conservation of the soil and its fertility by all available means has been incessantly carried on by the Department, the experiment stations, agricultural colleges, and by private publications. The importance of the cover crop to prevent winter erosion and to hold the humus and fertile elements of the soil for the benefit of succeeding crops has been one of the most emphatic teachings and has been prominent in every plan of crop rotation and farm management. The utilization of leguminous plants for enriching the soil, such as alfalfa, clover, and cowpeas, has been much extended throughout the country. So great has been the demand for cowpea, velvet bean, and crimson clover seed in the South that the farmers have been unable during the last two years to secure a sufficient quantity, even at very high prices.

VEGETABLE PATHOLOGY.

Plant diseases have been suppressed and avoided during the period under review in a far greater degree than ever before. A true science of plant pathology has been founded and the discovery of the causes and treatment of diseases has led to many improvements in mechanical methods of utilizing fungicides. Still greater advances have been made in the direction of plant sanitation, and improvements in the environment of plants as well as in the plants themselves have increased production, both in quantity and in quality. No part of the work of the Department and the experiment stations yields a more direct cash return than this.

A method of spraying trees has been devised which effectively prevents the bitter rot of apples, a disease which has caused in one year a loss of over $10,000,000.

A simple and effective method of preventing peach-leaf curl has been discovered which already saves hundreds of thousands of dollars annually. The peach-twig blight or gum disease of the peach, in California, is a disease which caused great loss of peaches in that State, but a method for its control has been discovered. The nature

and method of control of the disease known as "little peach," which has threatened to destroy the peach industry of Michigan and western New York, has been determined. A method of controlling the pear blight, a disease which has destroyed the best varieties of pears in many parts of the country, including $5,000,000 worth of orchards in California, has become effective.

A new spray—self-boiled lime-sulphur—has been discovered which may be safely used in spraying peaches for the control of the brown rot, a disease which has destroyed annually from 15 to 30 per cent of the peach crop. This mixture is also a valuable general spray, as an insecticide, and is effective in the treatment of San José scale.

Among numerous discoveries are the causes and the methods of control of the brown rot of cabbage, turnip, potato, tomato, and egg plant, and of numerous other bacterial diseases of crops; the withertip and orange blight of citrus fruits, two diseases which have caused great loss; and the cranberry scald and rot, causes of heavy losses. The cause of wilt disease of watermelon and cowpea has been determined and the disease has been avoided by the introduction and development of resistant varieties of these crops where old varieties will not grow.

Investigation of the causes of decay of timbers and the methods of preventing it has resulted in improved methods of handling timbers and in impregnating them with protective substances. A cheap and effective method has been discovered for treating fence posts to prevent decay.

INSECT PESTS.

Most civilized nations have quarantine regulations to exclude insect pests, and the United States is the only exception of prominence, but in this country the subject of remedies against this class of insects has received the greatest attention. The perfection of the lime-sulphur-salt wash has practically solved the San José scale problem, and recent investigations by the Department as to the use of hydrocyanic-acid gas against scale insects on citrus trees have been so successful as to promise the saving of a large number of orchards of great value.

The discovery of the original home of the San José scale in China by a learned expert of the Department and the introduction of its natural enemy into this country was an achievement of note, but the economical use of sprays has rendered the attempted establishment of the natural enemy a matter of comparatively slight importance. The tremendous effect of the spread of the San José scale was beginning to be realized twelve years ago, but in the meantime the efforts of this Department and of the experiment stations have enabled fruit growers to save their trees from this insect.

Much has been done in practically utilizing the natural enemies of injurious insects and in introducing into the United States beneficial insects of one kind or another. This Department has introduced into California the fig-caprifying insect, which has established a strong Smyrna-fig growing and packing industry. Parasites of the gipsy moth and of the brown-tail moth have been introduced which bid fair to relieve New England from the present danger to orchards and forests, and the rest of the United States from prospective danger.

Hawaii has introduced natural enemies of the sugar-cane leaf-hopper, which have relieved the sugar-cane crop of that territory from an immense burden. Successful experiments for handling the parasites of the Hessian fly promise to be of great value to the wheat farmer. An egg parasite of the imported elm leaf-beetle has been brought from Europe.

Within the period under review studies of the cattle tick and its allies have resulted in developing a system of cultural rotation which enables cattlemen in tick-infested localities to rid their land of ticks by a simple and effective process, and a movement under Federal auspices promises to result in the eradication of this insect.

In work concerning injurious insects, the United States has been a leader among nations. Other countries have appealed to this one for assistance and advice, as well as for men to carry on similar work.

USEFUL BIRDS.

Systematic observations have been made to identify the injurious and useful birds and wild animals. In a general way it is true that most of the birds are more beneficial to agriculture than otherwise. An increasing understanding of this fact has undoubtedly checked the ruthless destruction of nongame birds and is now promoting their preservation. Some of these birds are of very large economic value to the farmer. The services of the native sparrows in destroying weed seeds have been valued at many millions of dollars annually. Were it not for woodpeckers and other insect-eating birds there would be forest destruction. Caterpillars which destroy the foliage of fruit and shade trees are the food of birds. The scale insects that infest fruit trees are eaten by no fewer than 57 species of birds. The execution of the Lacey law for the protection of game is under the administration of this Department and the interstate transportation of game in violation of law has practically ceased.

VARIOUS DISCOVERIES AND IMPROVEMENTS.

Millions of dollars have been saved to the handlers of tobacco leaf by the Department's discovery of a fermenting process for curing cigar tobacco.

A simple, cheap, and effective method of destroying the harmful bacteria and the algæ in water has been discovered and its usefulness widely demonstrated.

The important discovery was made that the loco disease of range stock was due to a metallic poison absorbed by certain leguminous plants eaten by stock on the range, and this discovery has indicated methods of control.

Laws have been enacted to protect the farmer against fraud in the purchase of fertilizers, foods, feeding stuffs, seeds, disease and insect-infested plants.

Increased and wider knowledge of the nutritive value of food and of the better utilization of agricultural products as human food has followed the nutrition investigations of this Department, in cooperation with the experiment stations and other State institutions. Animal nutrition investigations, begun in cooperation with the Pennsylvania experiment station, are accumulating most accurate and scientific information, developed by use of the respiration calorimeter, an instrument invented by experts of this Department.

The Babcock test, invented at the Wisconsin experiment station, a simple method for determining the percentage of butter fat in milk, has entered more widely into use on the farm during the period under review, and a curd test has been invented for ascertaining the percentage of casein in milk, a matter of great importance to cheese factories.

Experiment stations have been established in Alaska, Hawaii, Porto Rico, and Guam, under the supervision of the Department. There is wider and more intelligent use of fertilizers, both farm-made and commercial.

Experiments conducted by scientific men in the feeding of farm animals to determine the relationship between feeds of different kinds and quantities on one hand, and gain in live weight in growing and mature animals on the other, have resulted in highly important discoveries which enable the farmer to feed with economy and to produce maximum results. One result of this new information is the marketing of meat animals at earlier ages than formerly, for which they are prepared by a forcing of growth. When approaching maturity of growth, the animal gains in weight at a greater and greater cost per pound of gain, and the fattening of a mature animal is a relatively expensive proceeding. Farmers have availed themselves of this knowledge generally throughout the principal live-stock States.

MARKETING PLANT PRODUCTS.

Marked improvements in methods of preparing, shipping, storing, and otherwise caring for the products of the soil have resulted from the practical field experiments of the Department and the stations. This work covers the storage of commercial seeds; the handling, transportation, and standardization of grain; and the handling and baling of cotton.

Perhaps the widest popular interest has been in the work of improved methods of caring for perishable products, chiefly fruits. The Department has examined the practices followed in the California citrus groves, in the warehouses, and in other features of the citrus industry of that State. In consequence of this, the Department has induced the growers and warehousemen to adopt improvements which are probably saving to their industry more than a quarter of a million dollars annually. These improvements include the picking of the fruit, methods of packing, loading on cars, pre-cooling, and, indeed, the whole process from tree to market. The conditions of transcontinental shipment have been improved and attention is now given to trans-Atlantic exportation. This work has been extended to the Florida citrus industry and the deciduous fruit industries of New York, Iowa, and other States.

Markets for perishable fruits, such as peaches and pears, have been opened in foreign countries, and, through improved methods of storing and handling, these fruits have been kept free from decay when shipped long distances. Improved methods of harvesting, storing, and handling apples have led to remarkable changes in the selling of the crop.

Great advance has been made in improving the methods of exporting and grading grain. An apparatus has been developed and introduced for quickly determining the moisture content of grain which has placed this feature of the inspection work on a satisfactory basis.

ANIMAL INDUSTRY.

The dairy cow maintains an industry whose products are worth more than the wheat crop or the hay crop or "King Cotton." They go to almost every one of the 19,000,000 families of the country as milk or butter or cheese, but more especially as milk. It is a matter of greater concern to the public than ever before that milk and butter should be wholesome and unadulterated. The quality and healthfulness of these products largely depend on bacteria. It has been necessary to educate the dairyman and the public in the exclusion of injurious bacteria and in the use of beneficial bacteria of such kinds as impart the desired flavors to butter and cheese. Such education has been immensely promoted by the work of the Department and of the experiment stations during the period under review.

This Department has organized and perfected a system of inspection of dairies and milk-distributing plants which within two years has been adopted by over 140 of the larger cities. It has great value in giving to dairies a definite rating on the basis of a score card in which 100 points are perfect, and the application of this inspection is distinctly educational. Definite things are pointed out where improvement can be made, and the system has been received with great favor by the authorities in charge of dairy inspection.

Under a special appropriation by Congress a systematic effort, in cooperation with State authorities, has been made to introduce dairying into the South where it has not existed before. It has been demonstrated beyond doubt that dairying can be carried on profitably in the South, and not only have southern farmers been enthusiastically engaged in the work, but some of the States have made appropriations for its extension.

Supplementary to the inspection of creameries performed by State dairy officers, this Department has initiated a system of market inspection of butter followed by reports back to the creameries in which it is made, the object being to provide the butter maker with information concerning defects. Through the efforts of the Department there has been a general awakening on the part of creamery owners and managers to the immense loss annually sustained by reason of incompetent business management, and the publicity given to this work has caused three great dairy schools to offer this winter for the first time special courses in creamery management.

The educational work of the past twelve years in behalf of improved dairy conditions has caused, through private means, the organization of a national dairy show association, which holds an annual show in Chicago. It brings together everything in dairying from the breeding and feeding of dairy stock to the finished dairy products in the form of butter, cheese, and milk. It is the center of a great annual gathering of dairymen in the broadest sense of that term and is becoming a great factor in dairy education and advancement.

Butter making in the home dairy and creamery has been almost revolutionized by the introduction of the farm separator, which separates cream from milk by a centrifugal process. The shallow pan or crock system and the deep-setting system have been largely eliminated, and with their exit a considerable part of the drudgery of the household disappeared. The farmer is now no longer required

to make the daily trip to the creamery; he can retain the skim milk to feed his calves and pigs and deliver the cream, sweet, every other day, when properly cared for, and this substitution of cream delivery for milk delivery by creamery patrons saves them labor and millions of dollars yearly in expense.

Dairy education at our agricultural colleges has proved most effective. Short "trade dairy school" courses have been provided for those already experienced in the work of cooperative and proprietary creameries and cheese factories. By such means American butter and cheese have been revolutionized in quality and uniformity and greatly increased in quantity and at the same time in the prices they command. Home dairying, as taught in agricultural schools, is also having a marked influence on the amount and quality of dairy products produced and on the profits from dairy farming.

Meat inspection under the National law has extended from a few of the larger packing establishments doing an export business in the largest cities twelve years ago to all the establishments of the country conducting an interstate or export trade in meat and meat food products. The scope of the work has been enlarged to include the supervision of the handling and the preparation of all meat food products and the sanitary conditions under which they are produced, as well as the thorough inspection of the animals for disease before slaughter and at the time of slaughter. Inspection is now maintained at about 800 official establishments; market inspection is maintained in 35 cities; certificates of exemption from market inspection are held by 1,992 retail butchers and retail dealers. During the year ending June 30, 1908, 54,059,901 cattle, sheep, swine, and goats had ante-mortem inspection; 53,973,337 of the same sort of animals had post-mortem inspection, and the meat and food products inspected weighed 5,958,298,364 pounds.

Important discoveries worth many millions of dollars to the farmers of the country have been made concerning the causes of and cures for animal diseases. The cause of hog cholera having been discovered, a cholera serum was prepared, and its use has demonstrated that it is a practical, trustworthy, and cheap preventive of this disease.

Methods of quarantine control of hog cholera have been worked out in some States and, with a preventive in the form of a serum, there is rising the hope that this disease, which causes millions of dollars of loss annually, may be eradicated.

After several years of experiments it was discovered by the Department that human tubercle bacilli were capable of producing tuberculosis in cattle, and that tubercle bacilli isolated from cases of tuberculosis in children possessed all the characteristics of tubercle bacilli of bovine origin, thus pointing strongly to the danger of human infection from bovine sources.

Great progress has been made in devising methods of freeing herds of cattle from tuberculosis. Some States have induced all breeders of pure-bred cattle so to handle their herds as to be able to sell only tuberculosis-free breeding animals.

In 1896, 35,000 doses of tuberculin and 1,200 doses of mallein were distributed free of charge to officers of health throughout the country for testing dairy cattle for tuberculosis and horses for glanders. In the year ending June 30, 1908, 213,000 doses of tuberculin and 52,000

doses of mallein were distributed. Thus it appears that the efforts of the Department to assist health officers and farmers in the reduction of bovine tuberculosis are bearing fruit. Since 1901 all imported cattle have been subjected to the tuberculin test.

In 1896 a satisfactory vaccine for the prevention of blackleg in cattle having been discovered, its manufacture and free distribution to the cattle raisers of the United States were begun. The use of this vaccine has constantly increased, and during the past fiscal year 1,154,100 doses were prepared and sent out.

Owing to the rapid extension of sheep scab over the ranges of the West, it was deemed advisable in 1900 to begin active measures for its restriction and eradication. This work has been continued subsequently and now several States have been entirely freed from this disease. In 1903 similar work was undertaken against scabies in cattle and considerable headway has been made toward the eradication of that disease.

A method was perfected in 1903 for the rapid diagnosis of rabies, which consists of microscopic examination of the central nervous system where the presence of minute animal cells, known as Negri bodies, indicates the disease.

The losses from milk fever in dairy cows formerly reached a high figure, since only the more valuable cows in the herd are affected. In 1904 it became known that the injection of sterilized atmospheric air into the udder of the affected animal almost invariably resulted in a cure, and this method of treatment has been widely adopted through the efforts of this Department.

Texas fever has long been a cause of serious losses to the cattle industry of the South. After the discovery that many sections of that region were but lightly infested with the cattle tick which causes Texas fever, a movement was started in 1906 for freeing such sections of this insect, with complete success within an area of 64,000 square miles.

A strict quarantine system protects our live stock against the dangerous infectious diseases which prevail in other parts of the world, so far as they are liable to be introduced by imported live animals; and when on rare occasions some malady, such as foot-and-mouth disease, gains entrance into the United States in some other way, it is promptly eradicated.

CROP REPORTING.

From the moment when the planting and sowing of the seed have begun, popular interest in the prospective quantity of the crop production continues until the harvest; and the interest in cotton, wheat, corn, and some other crops is world-wide. To provide information concerning the condition of growing crops, the amount of the harvest, the number of farm animals, and other statistical details at the earliest date and in such a way that it may be given to everybody at practically the same time, and not be available to even one person in advance, the Department's crop-reporting system has been recognized and safeguarded beyond peradventure of premature use of its reports.

Statements upon which these are mostly based are kept under seal and lock and key until they are considered, and the persons who handle them on the days when reports are issued are in confinement until these reports have gone by telegraph to every part of the coun-

try. Instead of being prepared by one person, as formerly, the reports are constructed by a corps of five persons, no one of whom can foresee what they will be in any particular.

The crop-reporting work has been much improved in other respects, one of the most important of which is the establishment and development of a service of traveling field agents, with three branches. One is a general service in which each man devotes all his time to travel and inquiry; another is a partial service of personal inspection performed by a man in each State, who also has a corps of correspondents, and a third is a special service for selected crops in which the field agents travel and devote their attention to their specialties.

So great have been the improvements of the crop-reporting service and so well is it protected against abuse that it never before stood so high in public estimation as it now does.

AGRICULTURAL CHEMISTRY.

At the beginning of the period under review the work of the Department in agricultural chemistry was confined to an analysis of soils, fertilizers, dairy products and cereals, and to sugar-beet investigations; at the close of the period there is not an industry nor an activity bearing upon the welfare of the farmer that is not studied chemically, whether he be considered as producer or consumer.

Only a few of the particulars can be mentioned and these briefly. The manufacture of sirup from cane sugar has been studied, including the fertilization of the plant, improved methods of manufacture, and the chemical control of the factory operations with a view to producing a profitable merchantable product. In connection with this the suppression of sophisticated products and the proper labeling of substitutes are seen to be of very great agricultural importance in fostering the production of legitimate sirup.

Environment studies based on the chemical examination of products grown in different parts of the United States under close supervision have afforded valuable information as to the effect of variations in temperature and rainfall on the sugar content of beets and Indian corn and the protein content of wheat.

A chemical study of the composition and effects of insecticides and fungicides, the establishment of the futility or even harmfulness of some of them, and of the loss to the farmer resulting from false claims made on the labels of such products, have led to a movement for National legislation on this subject, many of the States having already enacted laws governing the sale of such products.

The problems of soil analysis and fertilization have been attacked along the most painstaking and conservative lines, involving extensive pot experiments and the comparison of various methods of soil and plant analysis to determine the specific fertilizing needs of a given soil for a stated crop. The simple consideration of the determination of potash, nitrogen, and phosphoric acid in the soil has given way to the most complex studies of all soil constituents, both organized and unorganized.

Microchemistry and bacteriological chemistry have come to the aid of the soil and the food chemist especially and play a conspicuous part in solving the problems and meeting the emergencies which confront the practical chemist of to-day. Physiological chemistry has become an essential factor in the work, especially in the determination

of injuriousness of preservatives or coloring matters added to foods and the specific action of certain drug products.

An important piece of legislation, in which chemistry has played and must continue to play a conspicuous part, is the denatured-alcohol act, for only by opening up possibilities for the utilization of agricultural wastes in its production and ultimately furnishing to the farmer a convenient source of light, heat, and motive power, and to the trade a cheaper industrial alcohol, can the object of the law be fully attained.

The economic trend of much of the work in agricultural chemistry is further illustrated by the studies made to prevent the injury to forests, crops, and stock by wastes from smelters and factories, while at the same time the manufacturer may learn from the chemist, in many cases, to convert a waste, previously a menace, into an additional source of profit.

While the chemistry of the sugar beet twelve years ago was largely concerned with the problems of its introduction, the chemistry of to-day has to consider the improvement and extension of a successful industry, in the production of a beet of high sugar content, in solving the problems which arise in manufacturing the sugar therefrom, and in converting the wastes into merchantable products, the latter being successfully effected in several ways. Here, as in the canning industries, the production of tannins, the making of paper, and the production of turpentines, the part played by chemical research in improving processes, introducing new materials, and conserving resources reacts to the benefit of the farmer, not only in increasing the market for his produce, but by enabling him to improve the character of his crop and insuring the return to him of a better manufactured product. An investigation apparently so far removed from immediate interest to the farmer as the extensive paint and varnish investigations now making is found to concern him in the production of flaxseed for the manufacture of linseed oil.

The great agricultural interests of the country have had no more efficient and unflagging servants than the official chemists, both in Federal and State employ, who have labored in their behalf. As an index to the growth of this service it may be noted that the Association of Official Agricultural Chemists, which in 1897 mustered some 58 members with 9 referees, considering soil and fertilizer analysis, dairy products, fermented beverages, sugar, tannin, and feeding stuffs, in 1908 had 200 chemists assembled in convention who were concerned in the official control of foods and fertilizers, whose standards and methods are quoted in the courts, in administering the laws, and whose referees and associate referees, conducting work on every phase of food and agricultural chemistry, numbered about 50—nearly as many as the entire attendance at the meeting held twelve years ago.

PURE FOOD AND DRUGS.

Throughout this period the researches of chemistry into the composition of foods and their sophistication, and the publication of these results, have been slowly creating the public opinion which resulted in the passage of the food and drugs act of June 30, 1906. Back of this result lies a mass of laborious detailed work and scientific research necessary to differentiate between pure and impure products, to establish standards, to prove to the manufacturer the

practicability of maintaining such standards, and insure their maintenance in the courts. Should this seem a far cry from the progress of agricultural chemistry, it must be remembered that the repression of sophistication means the increased demand for the best and purest products, besides the protection of the public health.

The report of the Chemist for 1897 contained plans for work on infants' and invalids' foods and the study of cereals and milling products; the report for 1908 contains the account of the first year's work under the pure food and drugs act, with a fully organized corps of 40 inspectors at work in the field, 21 inspection laboratories scattered through the country, and behind these, as they were behind the first movement toward the law, scores of specially trained chemists and bacteriologists, performing not only the mass of routine chemical work necessary to inspection, but conducting researches into every phase of food and drug chemistry necessary to the just enforcement of the law. The public health ranks very high in the welfare of the Nation, and without the progress which has been made in agricultural chemistry, though it be detailed and not capable of description under specific discoveries, the need of the food law would hardly have been discovered and the public opinion necessary for its passage could not have been aroused, nor could its provisions have been executed after its passage.

ROAD IMPROVEMENT.

The United States has now entered upon a great era of road improvement. The State aid and State supervision plan, beginning with New Jersey in 1891, has been adopted in principle by about twenty States, resulting in large appropriations from State funds, skilled supervision by competent highway engineers, and in many cases the utilization of State prisoners for road work. In many States individual counties are accomplishing by large bond issues and practical management results as satisfactory as are accomplished by State aid.

The demand for men specially qualified in highway engineering is increasing at a rapid rate, and for this reason the Department has cooperated with educational institutions and urged the establishment of courses in highway engineering, or a modification of civil engineering courses, so as to provide the necessary instruction. Many colleges and universities are making definite progress along these lines. In connection with this movement, the Department has for several years appointed annually a small number of graduates in civil engineering and given to them thorough and practical training in highway work for one year. A number of these young engineers have passed from the Department's service to important situations in State and county road work.

The demands upon the Department for expert advice on road construction and maintenance have grown continuously in recent years both in volume and complexity, so that a corps of consulting highway engineers of the widest possible experience and adaptability has grown up, supplemented by specialists in various methods of construction and lines of experimentation.

Some States are rapidly giving more permanent construction to the principal highways. The State of New York in a recent year expended for this purpose more than $1,000,000; Massachusetts, about

$575,000; Connecticut, about $220,000; New Jersey, about $250,000; Pennsylvania and Vermont, about $130,000 each. Among the States that have pushed this work the more rapidly are Massachusetts and Rhode Island, where about one-half of the mileage of the public roads is improved; Indiana and Ohio, with more than one-third improved; California, with about one-fifth; Connecticut, Kentucky, New Jersey, and Wisconsin, with more than one-sixth; and Illinois, Maine, Maryland, Michigan, New Hampshire, New York, Tennessee, and Utah with about one-tenth.

WEATHER SERVICE.

The field of daily telegraphic meteorological observations for forecast purposes, which in 1896 was limited to the United States and Canada, has been extended by the Department to embrace at the present time the whole northern hemisphere. Forecasts which formerly were limited to a period of twenty-four to forty-eight hours in advance are now frequently made from four days to a week in advance. In 1896 forecasts were telegraphed daily at Government expense to 1,896 distributing stations, from which points they were distributed by mail, telephone, railway train service, and railway telegraph service to 51,694 addresses without expense. On June 30, 1908, the daily forecasts were being telegraphed at Government expense to 2,334 distributing centers, from which points they were distributed gratuitously to 76,154 addresses by mail, 58,008 by rural delivery, 2,139 by railway telegraph, 852 by railway train, and 3,553,067 by telephone, making a grand total of 3,690,220 addresses, of record, receiving the daily weather forecasts without expense, except for the initial cost of telegraphing the information from the forecast district centers. The storm-warning display stations have been increased from 253 to 321. There has been an addition of 78 stations where daily meteorological observations are taken and telegraphed.

The output of daily weather maps has been increased about 25 per cent, and a number of large glass maps for the display of weather information have been installed at the boards of trade and chambers of commerce of the principal large cities of the country.

The number of cooperative stations where observations of temperature and rainfall are made for use in establishing the climatology of the country has increased by 621.

The field covered by the river and flood service, which in 1896 embraced only the principal navigable rivers, has been extended so as to cover every river of importance in the entire country, except where the lack of necessary facilities has prevented efficient communication; and the number of district centers has been increased by 30, the river-gauge stations by 231, and the rainfall observing stations by 69.

A research observatory was established at Mount Weather, Virginia, in 1903, for studying the upper air and investigating the higher problems of meteorology. Problems of water evaporation have been investigated at the Salton Sea and at principal reservoirs of the Reclamation Service. The ocean meteorological service, which has been transferred from the Navy Department to this Department, now includes reports from over 2,000 cooperative observers, and from these reports are prepared data for publication on the Pilot Chart

issued by the Hydrographic Office. Buildings for use as meteorological observatories and living quarters for observers at stations have been erected or purchased at 37 places. Valuable works on climatology and meteorology have been prepared and published, including the climatology of the United States, a revised method for the reduction of barometric observations, and the preparation of new temperature and rainfall normals.

Great improvement has been made in the equipment of instruments used in the weather-forecasting service. A standard station meteorograph for the automatic and continuous registration of wind direction and velocity, sunshine, and rainfall has been developed and perfected, and every regular telegraphic reporting station is now equipped with it as well as with other automatic recording instruments, so that all local atmospheric conditions are now registered with great accuracy. A special meteorograph for use in upper-air exploration has been devised and brought to a high state of efficiency and is now used at the research observatory at Mount Weather.

To meet the demands for local meteorological data a form of street instrument shelter, or kiosk, has been devised, of neat ornamental design, for use in the parks or on sidewalks in busy parts of the larger cities. Within this shelter are displayed, behind protecting glass fronts, instruments giving continuous records of temperature, humidity, rainfall, etc., together with an appropriate display of daily weather maps, climatic charts, and other publications of special local interest.

The allotment of money for telegraphing and telephoning weather reports has been increased by 25 per cent during the period under review. New submarine cables have been laid from Key West to Sand Key, Florida; from Sleeping Bear Point to South Manitou and North Manitou Islands, Michigan; from Charlevoix to Beaver Island, Michigan; and from Point Reyes to the Farallon Islands, California—these isolated stations being maintained for the benefit of extensive shipping interests.

FOREST SERVICE.

For Americans ten years ago forestry had neither a practical basis nor practical interest. On July 1, 1898, there were two professional foresters in the employ of the Government, less than ten in the whole country, no school of forestry on the Western Hemisphere, no scientific knowledge of the first principles of American practice in existence. The very word forestry was usually meaningless except as it was misunderstood.

The foundations of the present National Forest policy had, it is true, been laid. Yet so feebly were these foundations supported by popular approval and so dubious was the prospect for rearing a proper superstructure upon them that there was no security for their permanence. President Cleveland had by his proclamation of February 22, 1897, turned at a single stroke over 21,000,000 acres of public land into National Forests, but because of the belief that this action meant their withdrawal from use a storm of protest had led to the suspension of the effect of the proclamation for a twelvemonth, during which the whole reserve policy hung in the balance. The law of June 4, 1897, which accomplished this suspension, also laid down the lines along which the Government's forest policy has ever since developed

by defining the purpose for which forest reserves could be created and authorizing their protection and administration; but not until more than half a decade afterwards was there an application of anything actually approaching forestry.

A complete change has been wrought in the attitude of the public toward the forests primarily and mainly by a knowledge of the facts shown by this Department. The change in public sentiment and the growth of forest service have been most rapid. The Department employed but 14 persons in 1897 in this work. Not an acre of land, public or private, at that time was under its care or receiving the benefit of its advice. There was no equipment for field work and frequently no information available upon which to base practical advice concerning forest management. The National Forests, with a total area of 39,000,000 acres, were about to receive for the first time some organized administration and protection through the General Land Office.

At the beginning of the fiscal year 1909 the Department employed 3,753 persons in its Forest Service. Its expenditures for the year 1908 were over $3,400,000. It administered an area of National Forests which before the end of the year aggregated almost 168,000,000 acres, and which paid into the Treasury of the United States over $1,800,000 in receipts. It supervised the cutting and removal of the equivalent of over 524,000,000 board feet of timber under methods which provide not only for the renewal of the forest growth but also for the improvement of its character. It prosecuted studies to further the best use of forests and forest products throughout the United States. It proved its capacity to manage the actual practice of forestry on the entire area of National Forests, embracing about one-fourth the timbered area of the country, whenever the public need brings full use of all the forests. It is equally prepared to take the lead in introducing forestry wherever in the United States its practice is desired. It has solved the problem of preservation through use, and thereby holds in its hands for the service of the public the means by which one of the most fundamental of our natural resources may be maintained in full and permanent productiveness.

RECLAMATION ACT.

New lines of work are coming to this Department and to State officials charged with looking after agricultural interests in consequence of the law of June 17, 1902, known as the Reclamation Act. When this began to provide income from the sale of public lands for the reclamation of arid lands by means of irrigating works, a movement of great magnitude began under the Department of the Interior, the results of which are already beginning to appear. The receipts of money for this purpose, beginning with the fiscal year 1901, had amounted to $33,302,855 by June 30, 1906; the estimated receipts during the following four years ending with 1910 are $24,800,000; so that by the end of the year last mentioned $58,000,000 will have been received and mostly expended to promote agriculture on desert land.

In the prosecution of this reclamation service, many projects have been planned, the irrigated area of which, as now appears, will be about 2,300,000 acres, at a cost of about $90,000,000.

Some of these projects for reclaiming land by irrigation have bold features which give evidence of the large scale on which the Govern-

ment is working to make the desert fruitful and to provide homes for hundreds of thousands of farming people—perhaps millions eventually.

The Salt River project in Arizona will irrigate 210,000 acres, and there must be made a tunnel nearly 2 miles long and a dam 1,080 feet long and 284 feet high, which will provide about 8,000 horsepower.

In the execution of the great Uncompahgre project in Colorado, which will irrigate 146,000 acres, it is necessary to excavate the Gunnison tunnel, about 5½ miles long, and another tunnel 2,000 feet long, besides excavating main canals for 77 miles and providing 5,000 to 10,000 horsepower.

The Minidoka project in Idaho, in its gravity project, will irrigate 84,200 acres, will have 130 miles of main canals and 190 miles of laterals, and provide 15,000 to 30,000 horsepower.

An irrigated area of 372,000 acres will be provided by the Payette-Boise project in Idaho, which will supply a power of 12,500 horsepower and utilize 200 miles of main canals and 100 miles of laterals.

A dam 6,200 feet long is part of the Belle Fourche project in South Dakota for irrigating 100,000 acres; the length of the main canals will be 100 miles, of the laterals 125 miles, and of the sublaterals 1,000 miles.

In 1896 the irrigated acres in this country numbered about 8,000,000; in 1908 the number is about 13,000,000, and, when projects now in the course of execution by the Reclamation Service and by private individuals under the Carey Act are executed, the total irrigable area will be 18,000,000 acres.

It therefore appears that during the period under review steps have been taken and much progress made toward placing under cultivation immense areas of desert land by means of irrigation and of so-called "dry land" by means of suitable cultural systems. The foundation has already been prepared for the advent of millions of people on previously unproductive land to pursue agriculture in many of its features under conditions which promise prosperity and an enormous addition to the Nation's permanent wealth and to its annual production. In these two lines of agricultural development, in which this Department has already been concerned in the agricultural phases, there is much work for it in the future.

AGRICULTURAL EDUCATION.

The total income of the agricultural colleges was $5,000,000 in 1897, $15,000,000 in 1908; the value of their property was $51,000,000 in the former year and $96,000,000 in 1907. The students in 1897 numbered 4,000; in 1908, 10,000.

One agricultural high school existed in 1897, and there are now 55. Not one normal school taught agriculture in 1897, but now 115 do so, besides many privately endowed schools. About half of the agricultural colleges now give training courses for teachers in agriculture; 44 States and Territories give some instruction in elementary principles of agriculture in the lower schools. The Graduate School of Agriculture for instruction of investigators and for discussion of advanced problems of research in agriculture was organized in 1902 and is now doing work under the American Association of Agricultural Colleges and Experiment Stations. A strong movement

for the systematic organization of all agencies in agricultural extension work has been started within a few years, and the National Educational Association has added a department of rural and agricultural education.

Outside of schools which are for the education of youth and teachers in agriculture, the farmers have received a greatly increased degree of education by means of demonstration work and advice given orally and by letter, by countless official and private publications, by corn and live-stock judging contests, and by farmers' institutes. The number of sessions of the last named held in 1908 was 14,000, with an attendance of about 2,000,000 persons, an enormous increase over the attendance twelve years ago. About 1,200 trained lecturers are now employed in farm-institute work in all States and Territories.

The volumes and pamphlets issued by the States and Nation now number many millions annually, and supplementary to this is the circulation of the periodical agricultural papers, amounting to many millions more.

In 1897 the number of publications issued by this Department was 424, of which 6,541,200 copies were distributed; in 1908 the 1,522 publications of the Department were distributed to the number of 16,875,516. During the eleven years following 1897 this Department has printed 10,449 publications, including reprints, the distribution of which amounted to 129,129,633 copies. If the probable numbers of this year are added, the publications of the twelve years will be about 12,000 and the distribution about 146,000,000.

The Department Library has grown from 56,000 books and pamphlets in 1897 to about 101,500 in 1908. Exclusive of annual reports of societies and institutions, 1,850 periodical publications are regularly received. The increasing use of this great storehouse of agricultural information is having educational effects that penetrate to every part of the United States.

GROWTH OF THE DEPARTMENT OF AGRICULTURE.

So increasingly disposed has the public been to ask and receive the aid of this Department, and so large have been the new fields of work assigned to it by Congress, that the number of employees has increased enormously. On July 1, 1897, 2,444 persons were employed, and eleven years later, in 1908, the number was 10,420, or over four times as many. Upon localizing this increase, it appears that the number of employees of the Weather Bureau increased from 1,075 to 1,705; of the Bureau of Animal Industry from 777 to 3,152; of the Bureau of Plant Industry from 127 to 976; Forest Service from 14 to 3,753; Bureau of Chemistry from 20 to 425; and small increases in other Bureaus and Offices. It is significant to note that the increase in number of employees is mostly due to service outside of Washington, in all parts of the country. The number of persons employed within Washington is 2,488, and elsewhere 7,932.

In 1896 the Department of Agriculture was made up of two Bureaus and a number of Divisions. Seven other Bureaus have since been organized and the work of the Secretary's Office has been developed into Divisions. The general change to bureau organization has greatly facilitated the work, which has rapidly grown in volume and in efficiency. There has been developed a remarkable force of

scientists, administrators, and helpers. The number of seasoned workers now ready to administer the research, the police functions, and the business of the Department is sufficient for any reasonable demand for new work.

A scheme of project statements has been devised which is centering in the Secretary's Office a plan for each line of work undertaken by the Department. This plan has now been so far tried by the Bureaus and also by a number of State experiment stations that its general use is assured. It promises to serve not only as a most valuable means of having plans for work thoroughly wrought out by leaders in charge of projects, aided by workers along similar lines and their superior officers, but also to be a most efficient agency to systematize permanently the organization of the activities of the Department.

The State agricultural colleges and experiment stations and departments likewise have developed corps of workers who are prepared to guide the great advances imminent in research, in education, and in scientific breeding. The relations existing among all these organizations were never so cordial as now, and far more effective cooperation is in vogue than ever before. The administrative officers and workers of the Bureaus of the Department and of the State institutions, having had experience in many forms of cooperation among themselves, have wrought out many of the principles governing these intricate cooperative relations.

RESULTS OF AGRICULTURAL SCIENCE ON PRODUCTION.

Tangible evidences of the beneficial results of the gigantic movement in agricultural instruction and improvement, of the unprecedented uplift of the farmer, and the betterment of country life, briefly outlined and indicated in the foregoing pages, are found in the wonderful increase in diversification and geographic extension of products, apart from any mere cultivation of new land, and are recorded with arithmetical precision by the increased production per acre of various crops for which facts are known.

It must be remembered that this country is passing through historical phases of agricultural production. First comes the exploitation of virgin land by the soil robber, a proceeding that is justified by the poverty of the settler or his lack of capital; next is the diminished production per acre, which surprises the farmer, and for which he is unable to account; next is the receipt of information from the scientist as to the means of improving the productivity of the land, with slow response; in the course of time, especially when the next or perhaps the third generation takes the farm, important advances are made, at first irregularly and mostly on the farms of the leading farmers, and subsequently with increasing diffusion and accelerated speed.

INCREASED PRODUCTION PER ACRE.

In the case of all crops for which production per acre is known, there was an increase during the last ten years and also, in a somewhat less degree, in the case of most of them, during the last twenty years. This is the general fact for the United States in spite of the damaging effect on the general average by reason of decreasing pro-

duction per acre from land that has not yet entered upon the final historic stage of agriculture.

The farmers of this country have now made a creditable beginning in this last phase of historic agriculture. It is now a movement of masses as well as of leaders. It is more and more a diffused movement in place of being broken up into localized efforts. This movement has gained most of its headway during the last twelve years. Increased production per acre is clearly indicating the extent and force of this uplifting movement.

During the ten years 1877–1886 the mean yield of cotton per acre in all States, new land and old being combined, was 170 pounds; during the ten years ending with 1896 the mean was 172 pounds; and the increase from that figure during the succeeding ten years ending with 1906 was to 191 pounds, or 11 per cent above the yield of the preceding ten years.

Most interesting now is the testimony of the older cotton States to the arts and sciences of agriculture. In North Carolina the mean production of cotton per acre increased from the ten years ending with 1896 to the ten years ending with 1906 by 21.8 per cent; in South Carolina, 20.4 per cent; in Georgia, 15.9 per cent; in Mississippi, 16.9 per cent; and in Tennessee, 11.5 per cent.

Other crops join hands with cotton in swelling the evidence. Within ten years, mean figures being adopted as before explained, the production of corn per acre in Ohio increased 17.5 per cent, and in Virginia 18.3 per cent; oats increased 17.9 per cent in Indiana.

Wheat increased 16.2 per cent in New York, 45.9 per cent in Nebraska, 14.5 per cent in Maryland, 19.1 per cent in Virginia; barley increased 13.6 per cent in Wisconsin; rye, 24.4 per cent in Pennsylvania, 14.5 per cent in Michigan; buckwheat increased 14.7 per cent in Maine and 21.9 per cent in Pennsylvania; potatoes 39.1 per cent in Maine and 22.1 per cent in Wisconsin.

Increase for hay was 14.3 per cent in Kentucky, 27.7 per cent in Minnesota, 19.4 per cent in North Carolina, 19.5 per cent in Georgia, 17.6 per cent in Alabama, and 30.8 per cent in Oregon.

In some degree this upward movement began twenty years ago, for during that time corn production per acre increased 25 per cent in Illinois and 21.7 per cent in Virginia; the production of oats increased 32.4 per cent in Maine; wheat increased 30.6 per cent in Iowa, 37.3 per cent in Nebraska, 23.4 per cent in Maryland, and 27.7 per cent in Virginia; rye increased 39.3 per cent in Pennsylvania; buckwheat increased 40.3 per cent in Maine and 26.9 per cent in Pennsylvania; potatoes increased 54.5 per cent in Maine, and hay increased 23.2 per cent in North Carolina, 32.8 per cent in Alabama, and 35.1 per cent in Oregon.

DIMINISHING RATE OF INCREASE IN POPULATION.

The most important meaning of the percentages of increased production per acre is found in a comparison with increase of population. The United States is accompanying the peoples of western and southern Europe in a decreasing birth rate and in a diminishing increase of population. The population of Europe, excluding Russia and Turkey, increased 8 per cent during the ten years ending with 1880, slightly less than 8 per cent in the ten years ending with 1890, and slightly more than 8 per cent in the following ten years. These people belong to the race stocks of the United States.

In this country the increase of population is complicated with an influx of the foreign born and with a higher birth rate of the foreign born than that of the old native stock. These are having a temporary effect upon the actual rate of increase; after an elimination of these temporary elements, which serve only to mislead to extravagant computations of population at distant years in the future, the natural rate of increase of the population of this country, native born of native parents, appears to be approximately 12½ per cent during a decade, or 1¼ per cent yearly, with a tendency toward diminution in the rate. This conclusion has been elucidated by the Chief Clerk of the Bureau of the Census in recently published writings concerning this subject.

The percentages of increase of crop production per acre now have a new significance. No one need fear that the farmers of this country will ever be unable to provide for its population. They are already demonstrating in the cases of various crops and of various States that they can provide for a population increasing faster than by increase due to excess of births over deaths.

The wheat and rye production of 12 countries of Europe, representing substantially the entire production outside of Russia and Turkey, increased by 15.2 per cent from 1886–1890 to 1901–1905, and the population increased from 1888 to 1903 but 13 per cent.

WAGES OF FARM LABOR.

Extraordinary prosperity following the low financial condition of farmers a dozen years ago and earlier has enabled them to pay higher wages for farm labor than before, and this fact may indicate an improved condition of the farm laborer, at any rate to the extent that he is disposed to improve.

From 1895 to 1906 farm wages increased in a greater degree than prices did. The percentage of increase of prices of all commodities, according to recognized authority, was 35.8 per cent, while the wages of farm labor by the month for the year or season without board increased 38.4 per cent and with board 41.4 per cent; wages by the day in harvest without board increased 46.5 per cent and with board 55.4 per cent, and the wages of ordinary labor by the day without board increased 55.6 per cent and with board 61.3 per cent.

In the matter of wage increase the farm laborer has fared better than the workingman employed in manufacturing and mechanical industries.

STATISTICAL ASPECTS OF PROGRESS.

Precise ideas of the progress of agriculture, of the farmer, of his capital, of his production, and of his financial improvement may be obtained by a quantitative comparison between the average of the last five years ending with 1908 and the average of the five years ending with 1896 or thereabouts. The comparison will indicate by percentages of increase the advance that the farmer has made in twelve years.

Cotton production increased 53.4 per cent and the total value of the crop 133.4 per cent; corn production increased 25.7 per cent, compared with the census of 1890, and the total value of the crop 110.5 per cent.

Wheat's increase is 39.8 per cent in bushels and 64.8 per cent in total value in comparison with the census of 1890. For rice the increase

of production is 303.3 per cent; the barley increase is 98.2 per cent for bushels and 130.9 per cent for total value.

For potatoes the increase is 35.5 per cent in production and 118.9 per cent in total value; for tobacco 35.3 per cent for production and 98.3 per cent for total value. Since 1892–1896 beet sugar production has increased 1,404.6 per cent.

The value of all products of the farm this year is an increase of 216.2 per cent over the census value of 1889.

Horses increased 33.6 per cent in number since 1890 and 81.2 per cent in total value; mules increased 68.5 per cent in number and 132.1 per cent in total value. Sheep increased 90 per cent in number and 224.5 per cent in total value; swine increased 22.1 per cent in number and 56.4 per cent in total value. Cattle, other than milch cows, increased 48.4 per cent in number and 64.9 per cent in total value, and milch cows 28.4 per cent in number and 77.8 per cent in total value.

The number of farms in 1890 was 4,564,641; in 1900 they numbered 5,737,372; and the present number is estimated to be 6,100,000, an increase of 33.6 per cent over 1890.

The total number of acres in farms increased from 623,000,000 in 1890 to 839,000,000 in 1900, or 34.6 per cent. Improved acres increased 15.9 per cent.

The capital of the farmer in the forms of land, buildings, improvements, live stock, implements, and machinery is supposed to be now worth about $28,000,000,000, an increase of 75 or 80 per cent over 1890.

The exports of agricultural products of domestic production have increased noticeably in value and in the case of many items greatly in quantity during the last dozen years. A comparison of the average for 1904–1908 with that for 1893–1897 discovers that the total agricultural exports increased 53.7 per cent in value, while the population increased 24.4 per cent from 1896 to 1908.

The increased value of the exports of packing-house products is 40.6 per cent. The exported lard gained 32.9 per cent in number of pounds and 52.6 per cent in value; oleo oil, 74.4 per cent in weight and 72.8 per cent in value; hams, 80 per cent in pounds and 90 per cent in value; salted and pickled pork, 121.8 per cent in quantity and 187.1 per cent in value.

The most prominent export, cotton, gained 40 per cent in pounds of export and 102.2 per cent in value; cotton-seed oil cake and oil-cake meal gained 115.5 per cent in quantity and 187.8 per cent in value, and cotton-seed oil about the same. Fresh apples gained 130.8 per cent in number of barrels and 224 per cent in value; all fruits gained in export value 237.8 per cent.

The farmers have given to this country most of its balance of trade in the exchange of goods with foreign countries from the beginning. To whatever extent the subject is complicated with shipments of gold and silver and with transfers of credit is immaterial to the present mention of the subject. The fact is that the farmers of this country, through the exportation of their surplus of products, have been the chief instrument of strengthening the National credit abroad, of paying the foreign holders of the National bonds of this country, and of establishing credit in foreign countries against which drafts could be made.

During the twelve years under review the agricultural balance of trade increased from a yearly average of $234,000,000 to $411,000,000, or 75.7 per cent.

As an indication of financial results, a comparison of individual deposits in all banks July 1, 1896, with those of 1908 presents striking gains in agricultural regions. While Massachusetts and New York were gaining, respectively, 61.9 and 12.2 per cent in deposits, and the North Atlantic States 112.1 per cent, the North Central States west of the Mississippi River gained 258.5 per cent; Iowa, 285.5 per cent; Kansas, 333.7 per cent; Mississippi, 404.2 per cent; Oregon, 725.6 per cent; North Carolina, 405.4 per cent; and Arkansas, 534.7 per cent.

While these were not all farmers' deposits, yet they were mostly derived from the sales of farm products by farmers and the handlers of farm products.

FARMERS' COOPERATION.

Farmers' economic cooperation in the United States has developed enormously during the period under review, and it is safe to say that at the present time more than half of the 6,100,000 farms are represented in economic cooperation; the fraction is much larger if it is based on the total number of medium and better sorts of farmers, to which the cooperators mostly belong.

PROMINENT OBJECTS.

The most prominent object of cooperation is insurance, in which about 2,000 associations have probably 2,000,000 members. This kind of insurance costs the farmers only a very few cents per hundred dollars of risk above the actual losses.

The cooperative creameries number more than 1,900 and the cheese factories about 260, the membership of the two classes being very large and representing an immense number of cows.

With the exception of insurance, the greatest success in the farmer's cooperative movement is in selling. Associations to regulate, promote, and manage the details of selling the products of cooperating farmers are found in all parts of the United States. There is cooperation for selling by fruit growers, vegetable growers, nut growers, berry growers, by live-stock men, by the producers of cotton and tobacco, wheat, sweet potatoes, flax, oats, eggs, poultry, and honey. Farmers cooperate to sell milk for city supply, to sell wool, cantaloupes, celery, cauliflower, citrus fruits, apples, and so on with a long list.

Cooperative buying is conducted by about 350 stores in this country, a majority of which are mostly owned by farmers. This is chiefly the result of a very recent movement. Another form of cooperation for buying is based on the discount plan, as carried on by the granges, farmers' clubs, and various other associations of farmers with cooperative buying as either a primary or secondary object. Things bought in this way are all sorts of store goods; potatoes, wheat, etc., for seed; coal and wood, and a great variety of farm and family supplies.

Warehousing is conducted by farmers on the cooperative plan with success, particularly for the storage of wheat and corn. A cooperative cotton-warehousing movement is of recent date.

Cooperative telephone service has permeated vast regions, and the cooperative feature has kept the cost at the lowest figure, both of equipment and of service.

Cooperative irrigation is carried on by many thousands of associations in the arid and semiarid regions.

EDUCATIONAL, SOCIAL, AND ECONOMIC ASSOCIATIONS.

The progress of farmers in forming and expanding associations of an educational and semi-economic character has made great advances during the period under review. These associations are National in their scope, or are confined to State lines or to sections within States, and are devoted to the interchange of ideas and experiences, the assembling of information for common benefit, the holding of competitive exhibitions of products, the devising of plans for the common good, and business of a like character, and are concerned with special subjects, such as horticulture, floriculture, dairying, plant breeding, live-stock breeding, poultry breeding, the scientific aspects of breeding, forestry, agricultural education, fraternal associations with incidental educational and economic features, seed breeding, agriculture, vegetable growing under glass, and the nursery business.

Important associations of the social sort, with incidental economic features, are farmers' clubs, many hundreds of which exist.

THE FARMER A GREAT ORGANIZER.

Altogether the number of farmers' cooperative economic associations must be fully 75,000, and may easily be many more, with a membership rising above 3,000,000, without counting duplicates.

Contrary to his reputation, the farmer is a great organizer, and he has achieved remarkable and enormous successes in many lines of economic cooperation in which the people of other occupations have either made no beginning at all or have nearly if not completely failed.

CONCLUSION.

The foregoing review of agriculture in the United States during the last dozen years and of the progress made by the farmer has necessarily been highly condensed, and from it has been omitted a vast amount of information which, being in the form of details, would detract from the review as it stands. Enough has been presented, however, to establish the fact that agriculture has made wonderful progress and permanent advancement, and that the farmer in results of information, intelligence, and industry has thriven mightily. The progress that has been made is in the direction leading to popular and National welfare, to the sustenance of any future population, as well as to a larger efficiency of the farmer in matters of wealth production and saving, and in establishing himself and his family in more pleasant ways of living.

Respectfully submitted.

JAMES WILSON,
Secretary.

WASHINGTON, D. C.,
November 27, 1908.

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